An investigation of students' computer-based learning strategies

Thesis

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Abstract

In recent decades, there has been a significant increase in the development and use of computer based learning technology in tertiary education. At the same time, researchers in the field of education have begun to develop an understanding of student learning in terms of learning strategies. Such constructs represent motives, behaviours and thought processes adopted by the student that are believed to mediate learning. This thesis investigates the learning strategies adopted by students using a computer-assisted learning system as part of their studies. Furthermore, the thesis examines the extent to which these computer-based strategies differ from learning strategies related to traditional teaching methods and tools.

The computer-based learning strategies of a population of distance education students were investigated using a CD-ROM. The students were studying the course Biology, Brain and Behaviour at the Open University and the Human Brain CD-ROM was an optional component of their learning materials. Data collected from questionnaires, interviews and observations over four studies led to the proposal of a framework of computer-based strategies. This framework comprises ten strategies that cover motivation, information processing and management of resources on the CD-ROM. When these strategies were compared to a framework of strategies related to the study of traditional teaching materials a number of differences emerged between the strategies used in the computer and traditional learning contexts.

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Contents

Tables

Figures

Chapter 1

INTRODUCTION

1.1. The purpose of this thesis

This thesis offers a novel way of understanding the way undergraduates learn with computers. It provides an assessment of this method of learning in terms of learning strategies. In turn, it presents a framework which educators and designers can use to gain insight into the way students use educational multimedia in terms of learning strategies.

Learning strategies are constructs that account for behaviours and processes used by students in their study of undergraduate degree modules or courses. They can provide insight into why and how students study a particular course. In the past, understanding student learning in terms of style appeared to be a process preoccupied with classifying students as particular learner types. The aim of learning strategy research is not to classify students, but their learning behaviours and processes. This approach allows for an examination of the various factors that make students' learning experience unique to them.

Research into the learning strategies of students has tended to concentrate on the study of traditional course material and traditional course delivery. Increasingly though, computer-based learning tools or environments are being used to complement, and in some instances replace, the traditional delivery of information via lectures, tutorials or textbooks.

The aim in examining the learning strategies that students use when learning with computers is simple. That aim is common to all learning strategy research – to understand the learning experience from the perspective of the student. With knowledge about the way in which students study and learn, instructors and designers can employ

teaching strategies that make the learning experience as successful and positive as possible for the student.

In the past, little research has examined the learning strategies that students employ when learning with computers (Sweany et al, 1996). What investigations have been carried out have tended to focus on navigational strategies (e.g. Chang and McDaniel, 1985; Verheij et al, 1996) or have been limited in the scope of the strategies examined (e.g. Lyman, 1998; Schroeder and Grabowski; 1995). Astleitner and Leutner (1995) propose that an examination of learning strategies in the use of computer-based learning environments could lead to a number of benefits. An important benefit would be the development of a reliable standardised measure of the different factors relevant to this way of learning. Such a measure is currently lacking, as is agreement over what behaviours to consider relevant to the learning experience in a computer-based learning environment. Another benefit Astleitner and Leutner propose is that an examination of computer-based learning strategies could provide a useful insight into the complex and dynamic interaction process that arises from using computing technology and its impact on learning.

These issues are investigated by the research carried out as part of this thesis that, firstly, broadens the scope of strategies explored by examining a range of factors that allow strategic behaviour to be identified. These include motivation to learn and study, the acquisition of knowledge and the management of time and effort spent with learning and study resources (Weinstein et al, 1987; Pintrich et al, 1989). As a result of this examination the thesis also presents a framework of computer-based strategies.

Another issue tackled by the thesis is the extent to which these computer-based strategies differ from traditional learning strategies. The research mentioned previously

has indicated differences in the types of strategies but because of the limitations identified it is difficult to assess the extent of these differences. An understanding of these differences adds to our understanding of the learning experience of students when using computers. In the thesis differences in strategic behaviour were examined by comparing the strategic behaviour of students using a CD-ROM with an established model of strategic behaviour. This model is considered an example of a 'traditional model' since it accounts for study practices in the traditional learning context and does not include the use of computers as learning tools. The model is well established and was developed at the University of Michigan (Pintrich, 1989; Pintrich et al, 1989). The CD-ROM that was used by the students in this research was called "the Human Brain CD-ROM". It has been developed as an optional learning aid for the Open University course – SD206: Biology, brain and behaviour.

To summarise, the purpose of this thesis is to broaden our understanding of computer-based learning behaviour in terms of learning strategies. By doing so, the intention of this thesis is to provide educators and designers greater insight into the learning experience of the student using the computer as a learning tool. The remainder of this chapter outlines the general aims of the research contained within this thesis and provides an overview of thesis' content.

1.2. The research aims

The programme of research was designed to address two main aims of the thesis:

- To determine what learning strategies students use when learning with computers
- To determine the extent to which students' computer-based learning strategies differ from the traditional conceptualisation of learning strategies

1.3. Overview of the thesis

In the next chapter, **Chapter 2**, the empirical research that contributed to the thesis is framed with an examination of the literature related to two broad areas associated with this thesis: our understanding of students' learning and learning with computers. The first of these areas examines how our understanding of students' learning behaviour in higher education has evolved over the last fifty years or so. The changes that have occurred are explained in terms of a move from cognitive style to learning style and from learning style to learning strategies. In terms of learning strategies, the chapter concentrates on how our understanding of strategic behaviour has been cultivated since the 1970's.

The chapter then goes on to explore previous research that has investigated the learning strategies of students when working computers.

Chapter 3 begins by detailing a conceptual framework of learning strategies and an associated measure of strategic behaviour, the Motivated Strategies for Learning Questionnaire or MSLQ developed at the University of Michigan (Pintrich, 1989; Pintrich, Smith, Garcia and McKeachie, 1989). The study reported in this chapter, Study I, examined the reliability of the MSLQ when tested with a sample of students who were studying a biology course in the UK at a distance.

Chapter 4 outlines the methodology adopted throughout the remaining studies and the research programme that was undertaken. The overall methodology was that of a survey approach comprising of questionnaires and interviews. The chapter also details the populations and samples in the studies that were conducted and the CD-ROM that would form the basis of the learning investigation. The chapter also outlines and supports the investigative approaches associated with the studies and the subsequent analysis of their findings.

Chapter 5 reports on the second study in the programme of research, Study II. This represented the first investigation in the thesis of students' computer-based learning behaviour. The chapter reports on the experiences of eight students who used the CD-ROM. From interviews conducted with these students, an initial framework of strategies is presented.

Chapter 6 reports on Study III that consisted of a questionnaire study of computer-based learning behaviour. The chapter details the analysis of data collected from 96 students who used the CD-ROM. Following Item and Factor analysis a series of factors or strategies emerged and these are also discussed.

Chapter 7 reports on the final study in the research programme, Study IV. Again, interviews were conducted with twenty students who used the CD-ROM. The study aimed to extend the findings from the two previous studies. The findings of the study confirmed the existence of some the strategies identified in Study II and III and led to a number of new strategies being identified in the framework.

Chapter 8 offers a synthesis of the findings from all the studies conducted in terms of this thesis. It details a framework of the computer-based learning strategies that emerged from the programme of research and examines how this conceptualisation differs from the traditional models of learning strategies.

Chapter 9 presents the achievements of this thesis, their implications for our understanding of students' computer-based learning, along with the implications for educators and designers of media. The chapter also considers limitations of the research and its potential in terms of further research into students' computer-based learning strategies.

Chapter 2

A LITERATURE REVIEW OF LEARNING STRATEGY THEORY AND RESEARCH IN HIGHER EDUCATION

2.1. Introduction

This chapter examines the literature related to two broad areas of research that frame this thesis. The first part of the chapter examines the changes that have occurred over the last fifty years or so in our understanding of how university students learn. The latter part of the chapter examines the implications of these changes for understanding how students learn with computers.

From this review a two main points emerge: firstly, because of the problems associated with the notion of styles of learning, learning strategies offer a more viable way of exploring the way students learn. Secondly, there has been a failure to investigate a range of learning strategies that students adopt when learning with computers and whether these strategies differ from established models of strategic behaviour. This gap in the literature provides the impetus for the research detailed in following chapters.

The literature concerning the study practices of students in computer-based learning environments has gradually increased over the last two decades. Much of the existing literature has focused on the relationship between learning styles and the learning outcomes of a computer-based learning task. Generally, the aim of this work has been to increase our understanding of the demands that CAL tools place on the different learning patterns of learners or different groups of learners. However, it will be argued that it is questionable whether such studies actually fulfil that aim.

2.2. Understanding student learning in higher education

> *'[the University] is a place where those who hate ignorance may strive to know, where those who perceive truth may strive to make others see; where seekers and learners alike, banded together in the search for knowledge, will honour thought in all its finer ways, will welcome thinkers in distress or in exile, will uphold ever the dignity of thought and learning and will exact standards in these things.'*

The excerpt above appeared in an address John Masefield made to the University of Sheffield in 1946 to sum up the role of higher education. The quote also appears in the Dearing Report (Dearing, 1997) on Higher Education in United Kingdom. The report proposes a vision of higher education in the future and the contribution it can make to a learning society. That is, a society in which there is access and benefit from higher education for all people throughout their adult life. The committee reported that with increased and wider participation, coupled with progressive developments in information and communication technologies, the next twenty years will be a period of major change in the sector. A number of recommendations are provided by the committee to accommodate these changes but in relation to the focus of this thesis two stand out:

> ***Recommendation 8: We recommend that, with immediate effect, all institutions of higher education give high priority to developing and implementing learning and teaching strategies which focus on the promotion of students' learning. (Chapter 8, p116)***

> ***Recommendation 9: We recommend that all institutions should...review the changing role of staff as a result of communications and information technology, and ensure that staff and students receive appropriate training and support to enable them to realise its full potential (Chapter 8, p121)***

Linked to these recommendations are the following qualifications:

> *"...an effective strategy will involve guiding and enabling students to be effective learners, to understand their own learning styles, and to manage their own learning. We see this as not only directly relevant to enhancing the quality of their learning while in higher education, but also to equipping them to be effective lifelong learners. Staff will increasingly be engaged in the management of students' learning, using a range of appropriate strategies." (Chapter 8, section 15)*

> *"One of the benefits of new technology lies in providing a learning environment that may succeed in improving understanding where other methods have failed. Computer-based programmes, such as tutorials, simulations, exercises, learning tools and educational games can be highly interactive and provide activities that students need to develop their understanding of others' ideas and the articulation of their own...But its use for learning is still at a developmental stage. For a full and successful integration into learning to take place, staff need to be effective practitioners and skilled in the management of students' learning through C&IT." (Chapter 8, Sections 24 and 36)*

These excerpts and the report in general, recognise that learners in higher education are increasingly becoming a heterogeneous population but the committee also reports that success should be attainable for all. Such success essentially depends on the combination of effective teaching and effective learning and both can potentially be accommodated through the use of new computer-based technologies.

The report indirectly acknowledges that there are variations in approaching academic learning and that some practices are more suited to success but fails to specify their nature and to consider how they relate to computer-based learning (Jones, Jacobs and Brown, 1997).

The remainder of the chapter traces how we have sought to understand student learning over the last fifty years or so, what we have discovered about the ways in which students differ and the impact of this research for understanding how students learn with computers.

2.3. Styles of learning

The first half of this chapter is dedicated to outlining what can be regarded as two main epistemological shifts in the research and theory concerning student learning in terms of style and strategies: from cognitive style to learning style, and from learning style to learning strategy.

The earliest understanding of differences in the way students approached learning in higher education was in terms of cognitive style. Messick (1984) traces its use over a period spanning forty years and identifies various definitions that have been proposed in an attempt to characterise cognitive style. These definitions, although distinct, appear to maintain a common principle - that cognitive styles are consistent individual differences in terms of organising and processing both information and human experience. However, according to Messick this notion of cognitive styles, as merely modes of cognition, ignores their deeper roots in personality. Instead, Messick offers the following conceptualisation of cognitive styles:

> *"characteristic self-consistencies in information processing that develop in congenial ways around underlying personality trends" (Messick, 1984; p61)*

Messick outlined the kinds of educational benefits that an understanding of cognitive styles could contribute to in improving instructional methods including: enriching teacher behaviour and conceptions; enhancing student learning and thinking strategies; expanding guidance and vocational decision making; broadening educational goals and the outcomes of the educational process. However, he conceded that, realistically, such benefits remained unrealised. The main reason for this, he argues, is that the measurement of cognitive styles is fraught with problems. The most notable problem has been that of obtaining a construct-valid measure suitable for large-scale assessment. This could be because the definitions of cognitive style have been too broad and the

agenda in terms of educational benefits has been too ambitious. Nevertheless, most early research which concentrated on the way in which individuals differed in terms of academic learning was based largely on notions of cognitive style, along with psychometric and ability measures.

More recently, Riding and Rayner (1998) have re-examined the conceptualisation of cognitive style and they too draw upon the same definition as Messick, although they consider the construct to have a biological basis. They concede that in the past educational research that has examined differences in terms of cognitive style has at best been irrelevant and at worst been dangerously misguided. However, they argue that there is an increasing awareness of the construct's existence and usefulness.

Whereas today the construct of cognitive style may have some usefulness in examining student learning, many researchers, predominantly in the 1970's, moved towards a view of style that reflected the individual's response to learning in higher education (Rayner and Riding, 1997; Riding and Rayner, 1998). This move represented an attempt to bridge the gap between theoretical proposals of individual differences and differences witnessed in the academic environment (Grikerenko and Sternberg, 1995). What emerged was the concept of learning styles, a conceptualisation that brought together the information processing and personality dimensions of cognitive style and applied them to the academic context. The term also acknowledged a difference between general information processing and the cognitive processes, essentially processes associated with learning that took place in the classroom.

Riding and Rayner (1998) identify a series of major defining features of the learning style construct. These include: a focus on the learning process; the impact of individual differences on pedagogy; the enhancement of learning achievement and the construction

of an assessment instrument as the foundation for the exposition of theory. They offer a general definition of learning style as an:

> *"...individual set of differences that include not only a stated personal preference for instruction or association with a particular form of learning but also individual differences found in intellectual or personal psychology." p51*

Over time, the term "learning style" has been used both synonymously with, and in contrast to, the terms "learning approach" and "learning orientation". This ambiguous set of terms arises from the fact that a number of different style models have been proposed by researchers and most have been widely used and accepted.

To overcome this confusion, Rayner & Riding (1997) and Riding & Rayner (1998) have rationalised the various conceptualisations of learning style into four basic categories (see Table 2.1). The first three categories of style are generally concerned with the process of learning and the context in which it occurs and identify three main types of style differences based on learning processes, approaches or orientation to study, and preference for particular aspects of the learning environment. A fourth group of style relates to the development of a variety of cognitive skills and abilities associated with learning. A common feature of these style conceptualisations is that they allow individuals to be identified as a particular type of learner or member of a 'learner-group'.

Riding and Rayner (1998) concede that the rationalisation of the learning style concept offers only a partial solution to the main problem caused by the number of different learning style models. That problem is variation and inconsistency in terms of the learning style construct concept that has had the effect of inhibiting the development or application of learning style in the field of education (Riding and Rayner, 1998).

They propose that to make the conceptualisation of style useful, relevant and pertinent to the academic setting, it needs to be reconciled with the notion of students learning strategies that they define as:

> *"...formed as part of a response within the individual to meet the demands of the environment. Learning strategies may thus be seen as cognitive tools which for the individual are particularly helpful for successfully completing a specific task."p79*

This conceptualisation is shared by other researchers who have also claimed learning strategies are the underlying components of the learning style construct (e.g. Biggs, 1979; Pask, 1976, 1988; Schmeck, 1988a, 1988b, 1988c). In view of the problems associated with the definition of the style concept, an increasing number of researchers and educators have become less concerned with typologies of learner groups or general patterns of behaviours. Instead they have become more interested in the processes that individual students employ in their learning - their learning strategies.

Table 2.1 Models and key features of learning style (Rayner & Riding, 1997; Riding & Rayner, 1998)

Dimension	Description	References
Style models based on the learning process		
Concrete experience/Reflective observation/Abstract conceptualisation/Active experimentation	A two-dimensional model comprising perception (concrete/abstract thinking) and processing (active/reflective information processing).	Kolb (1976)
Activist/theorist/pragmatist/ reflector learners	Preferred models of learning which shape an individual learning approach.	Honey and Mumford (1986, 1992)
Style models grounded in orientation to study		
Meaning orientation/ Reproducing orientation/ Achieving orientation/ Holistic Orientation; later developed to included Deep, Strategic, Surface, Lack of direction, Academic self-confidence	An integration of instructional preference to information processing in the learner's approach to study.	Entwistle (1979, 1981); Entwistle and Tait (1994)
Surface-deep-achieving orientation/ intrinsic-extrinsic-achievement orientation	An integration of approaches to study with motivational orientation	Biggs (1979, 1987)
Synthesis-analysis/ elaborative processing/ fact retention/ study methods	The quality of thinking which occurs during learning relates to the distinctiveness, transferability and durability of memory and fact retention	Schmeck et al (1977)
Style models based on instructional preference		
Environmental/ sociological. Emotional/ physical/ psychological elements	The learner's response to key stimuli: environmental (light, heat); sociological (peers pairs, adults, self); emotional (structure, persistence, motivation); physical (auditory, visual, tactile); psychological (global-analytic, impulsive-reflective).	Price et al (1976, 1977); Dunn et al (1989)
Participant-avoidant/ collaborative competitive/ independent-dependent	A social interaction measure which has been used to develop three bipolar dimensions in a construct which describes a learner's typical approach to the learning situation	Grasha and Riechmann (1975)
Style models based on cognitive skills development		
Visualisation/ verbal symbols/ sounds/ emotional feelings	Learning style defined in terms of perceptual modality	Reinert (1976)
Field-dependency/ scanning-focusing/ breadth of categorisation/ cognitive complexity/ reflective-implusivity/ levelling-sharpening/ tolerant-intolerant	A cognitive profile of three types of learners reflecting their position in a bi-polar analytic-global continuum which reflects an individual's cognitive skills development.	Letteri (1980)
Cognitive skills/ perceptual responses/ study and instructional preferences	Identifies 24 elements in a learning style construct grouped together into 3 dimensions. The model presupposes that cognitive skills development is a prerequisite for effective learning	Keefe and Monk (1986); Keefe (1987, 1989a, 1989b, 1990)

2.4. Learning strategies

Most of the theory and research related to learning strategies emerged in the 1970's, in the USA, and represented progress by educational psychologists in understanding and improving classroom learning (Snowman, 1986). This progress coincided with a shift away from the prevailing behaviourist paradigm towards a more cognitive orientated view of learning.

One of the aims of this thesis is to identify how computer-based learning strategies differ from those used in the traditional learning setting comprising often of lectures, tutorials and required reading from textbooks. It is in this setting that learning strategies have their origins and the purpose of this section is primarily to establish how our understanding of these processes and behaviours has increased over the last twenty to thirty years. This section also serves to outline some of the models that have been used in previous research examining computer-based learning strategies. These studies are discussed in greater detail further along in this chapter.

Regardless of whether the research has been concerned with traditional or computer-based learning strategies, it has primarily been carried out in the USA. The reason for this can be linked to a national, post war, trend in the 1960's for American universities to accept students that they would previously have not admitted. As a result American colleges and universities were faced with an increasing number of students who lacked the skills necessary to succeed in tertiary education (Weinstein and Underwood, 1985). The problem was how to address those deficits; the solution was to develop a better understanding of their learning practices – their learning strategies

For the last three decades, research on students' study practices has been a thriving enterprise, but like the learning style concept, confusion now exists about what the term

'learning strategy' actually refers to (Derry, 1990). Derry identifies three main aspects of student learning where researchers have commonly used the term 'learning strategies'. These include particular learning skills (e.g. notetaking, underlining), more general types of self-management activities (e.g. planning, monitoring) and complex plans that combine various study activities and behaviours. This section explores a number of definitions offered by different researchers with a view to framing the investigation of learning strategies in this thesis.

One of the earliest definitions of learning strategies was provided by Dansereau, (1978) who claimed:

> *"...an exclusive emphasis on teaching methods may lead to ineffective instructional manipulations, force students to develop non-transferable and inefficient strategies, limit a student's cognitive awareness, and, consequently, extract a large emotional toll. The answer to this situation is clear: educators and researchers should be redirecting at least some of there efforts to the development and training of appropriate learning strategy skills." (p2)*

For Dansereau, the investigation of learning strategies presented an opportunity to improve student learning in light of the fact that his own research, carried out in the early 1970's, had suggested that different teaching methods were ineffective at achieving that improvement. It also represented a move away from behaviourist models of researching and improving instructional goals towards a cognitive approach to education that was just emerging at that time (see also Weinstein and Underwood, 1985). Dansereau distinguished between two classes of strategies: primary strategies and secondary strategies. Primary strategies referred to activities used to operate directly on the teaching materials, for example, determining important information, novel information and comprehension. Secondary strategies allow the primary strategies to be used efficiently and effectively. That is, they maintain concentration and focus on the learning task or goal.

More specifically, Dansereau defined a strategy as a set of processes that facilitate the acquisition, storage and/or utilisation of information (Dansereau, 1985). He also proposed a number of dimensions along which strategies could vary. For example, a strategy could be algorithmic, where a student carries out a sequence of mental processes and these remain constant over tasks, or it could be heuristic, where a sequence of processes is dependent on the task and learner. Dansereau also claimed that strategies could differ in terms of the scope of the task they could accomplish and to what extent they were dependent on the learning context.

Also in the late 1970's, Rigney (1978) distinguished between detached and embedded information processing strategies. The former refers to strategies prescribed independently of the subject matter, for example, notetaking, comprehension. 'Embedded strategies', however, are activities that form part of the instructional method used to teach students about the domain, for example, inserting questions at the end of a text book chapter. Rigney also claimed strategic behaviour could be initiated either by the individual at their discretion or be facilitated by the instructional system either explicitly or implicitly.

In the 1980's, the definitions of strategy broadened to include both instructional and environmental influences. For instance, Kirby (1984) defined a strategy as a method for approaching a task, or more generally attaining a goal. He also distinguished between macro-strategies (general behaviour that emerges from cultural or stylistic differences) and micro-strategies (task or domain specific abilities that are more responsive to instruction). These could also be considered as being at opposite ends of a continuum. A similar distinction was made by Biggs (1984) who incorporated the notion of strategies operating at different levels into a comprehensive model of variables that are involved in academic performance (see Figure 2.1).

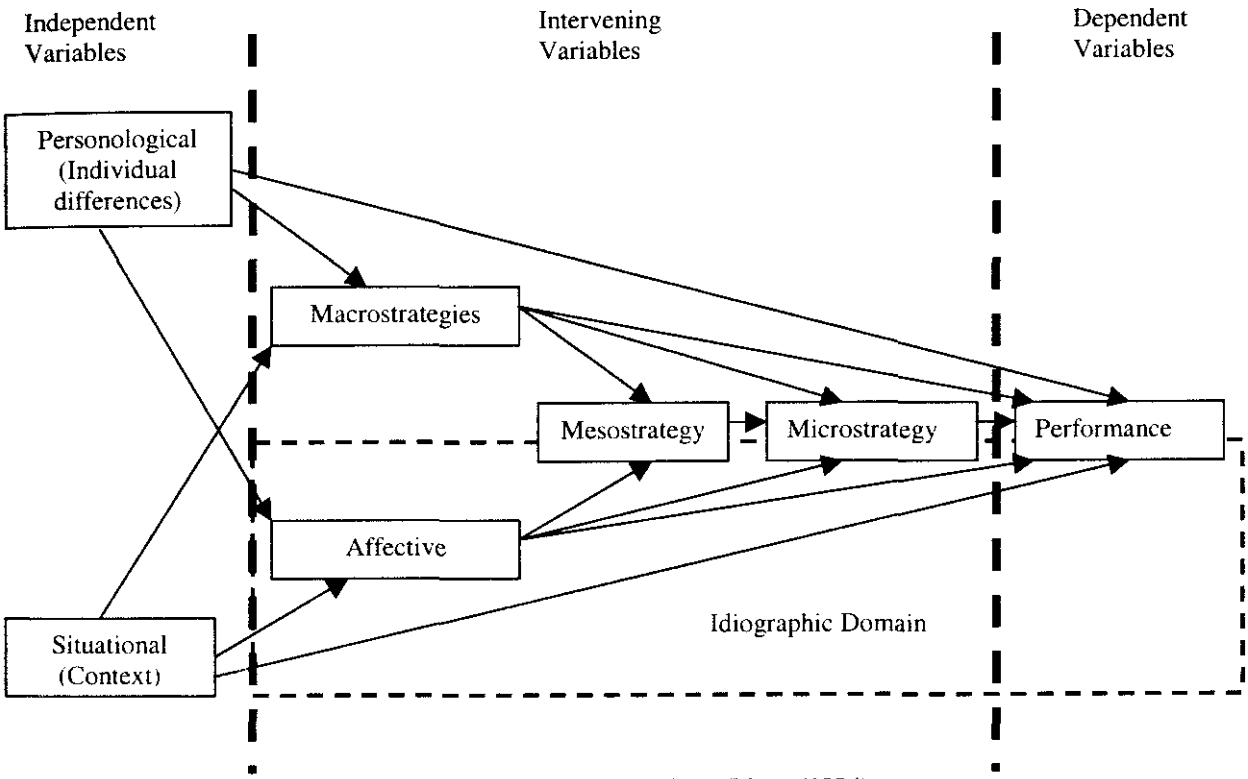


Figure 2.1. Adapted from Biggs (1984)

In the model three broad sets of variables can be distinguished. The first of these, independent variables, are the variables the individual brings to the learning situation and which are independent of the learning task. These include personality, culture and prior experience. These variables also include the nature, content, difficulty and evaluation of the task. Such factors exist prior to any performance outcome and so are therefore also considered independent.

The second type of variables, intervening variables, is where strategic activity comes in to play and includes the macro and micro strategies described by Kirby and also a further type of strategy that Biggs termed meso-strategies. This type of strategy refers to typical behaviour in the context of academic performance and reflects Rigney's conceptualisation of detached strategies. The final type of variable, dependent variable, comprises the performance outcome of the task in terms of how the well the students did compared to others on the same task or in terms of the student's own expectations. These variables and the strategies have various interrelationships that are depicted in figure 2.1.

Thus, by the mid-eighties definitions of learning strategies referred to particular activities such as notetaking along with cognitive processes such as rehearsal and elaboration. Strategies were also identified to operate at different levels, as seen in the work of Kirby and Biggs and were more than simple sequences of behaviour. They could also be encouraged by particular instructional methods or implemented by the individual. Also, according to Nisbett and Shucksmith (1986), strategies were almost always directed towards the achievement of a particular goal, that is, strategies had a motivational component.

Around the same time, one of the most comprehensive models of strategic behaviour was proposed by Weinstein and Mayer (1985). They offered a definition of strategies as behaviours and thoughts intended to influence the learner's encoding processes, i.e. the selection, organisation and integration of information. Their model identified eight main categories of strategy covering mainly information processing behaviour but also affective and motivational influences, see table 2.1.

Table 2.2: Weinstein and Mayer's (1985) strategy taxonomy

Categories of strategy	Examples of behaviour
Basic Rehearsal	Repeating items in an ordered list
Complex Rehearsal	Copying, underlining
Basic Elaboration	Forming a mental image or sentence relating to particular items of information
Complex Elaboration	Paraphrasing, summarising, or describing how new information relates to existing knowledge
Basic Organisational	Grouping or ordering to-be-learned items from a list or section of prose
Complex Organisational	Outlining a passage or creating a hierarchy of information to be learnt
Comprehension Monitoring	Checking for comprehension failures, *includes use of inserted questions and* objectives
Affective and Motivational	Being alert and relaxed to overcome test anxiety

Weinstein and Mayer's model helped to rationalise an increasing number of behaviours and processes identified as learning strategies. However, like the learning style construct, the diverse and widespread research into learning strategies presented a barrier to their application and use in the academic setting. Specifically, universities and colleges continued to consider it important to address the needs of unprepared learners, but their efforts were hampered by a number of problems and inadequacies associated with the diagnosis and assessment of strategic behaviour (see Weinstein, 1988; Weinstein, Zimmermann and Palmer, 1988). Common problems included a lack of diagnostic validity for the instruments that had been developed to measure strategic behaviour and inconsistent or definitions of particular study skills that were too broad. The Learning and Study Strategies Inventory (LASSI) developed by Weinstein, Schulte and Palmer (1987) attempted to overcome such problems. Following more than ten years of testing and development, it is designed as a diagnostic tool and an aid to remedial learning strategy teaching. A decade after its original publication, it was reported as the most widely used learning inventory on college campuses, used by more than half of American colleges (Murray, 1998).

The LASSI currently contains 77 items with responses made to statements on a 5 point Likert scale. The instrument identifies ten strategies these include: attitude, motivation, time management, anxiety, concentration, information processing, selecting main ideas, study aids, self testing, and test (see Table 2.1 below). Half the subscales relate to motivational and affective influences, the other scales measure information processing behaviour. These strategies emerged from empirical findings and add to our understanding of the categories of strategies identified by Weinstein and Mayer (1985).

The research process and outcomes associated with the LASSI also offer an example consistent with Mayer's (1988) argument that any useful theory or model of learning

strategies must be based on an underlying theory of human learning. He identified two broad types of learning theory: that aimed at determining how much is learnt and that aimed at determining what is learnt.

In terms of the 'how much is learnt' theory, the formulation of strategies should contribute towards improving student learning behaviour. In terms of the 'what is learnt' set of theories, strategies should be useful in influencing the kind of learning that takes place. In both cases this is achieved by the way in which the LASSI has allowed us to identify, assess and adapt the components of the learning process. According to Mayer, notions of learning strategies should be relevant to four main components of academic learning: instruction, learning processes, learning outcomes and performance. The success of the LASSI research in addressing these areas in relation to tertiary education has seen its principles of strategic behaviour also applied to primary/elementary education (Weinstein and Hume, 1998).

In recent years, learning strategies have also been considered in terms of Bandura's (1977, 1986) social learning theory. The theory incorporates notions of attention, cognition and motivation into an understanding of how and why learning occurs and has in the last ten years or so given rise to the notion of self-regulated learning (Pintrich, Wolters and Baxter, 2000).

A major proponent of this approach to academic learning has been Zimmerman (1986, 1989; Zimmerman and Pons, 1986). Self-regulation theory focuses on how students personally activate, alter and sustain their learning practices in particular contexts (Zimmerman, 1986). The theory incorporates three main elements: self-efficacy, academic goals and self-regulated learning strategies (Zimmerman, 1989). A learning strategy is considered an action that is directed at acquiring information or a skill, it has

purpose and motive and is linked to self perceptions of the learner in terms of autonomy, competence or efficacy (Zimmerman and Pons, 1986).

Self-regulation also views the response to tasks as constantly monitored and refined, with the learner able to draw on a repertoire of skills or strategies to successfully complete the task (Winne, 1995). The role of the learner is emphasised as one involving control, selection and adaptation. However, these learning processes are dependent and inseparable from the learning context in which it occurs (Alexander, 1995).

In meeting the aims of this thesis, i.e. to determine the nature of computer-based strategies and how they compare to those used in the study of traditional course material, a particular model of strategic behaviour was selected as the basis of the four studies reported in the following chapters. The learning strategies model and questionnaire chosen were the Motivated Strategies for Learning Questionnaire (MSLQ) developed by Paul Pintrich and colleagues at the University of Michigan (Pintrich, 1989; Pintrich, Smith, Garcia and McKeachie, 1989).

Although a number of models and instruments were considered, the decision to use the MSLQ was based on two main aspects of its use and development: firstly, the MSLQ has been documented as a reliable measure of student learning. Secondly, the MSLQ was considered to be more sensitive to the learning contexts under investigation compared to other measures such as the Learning and Study Skills Inventory or LASSI (Weinstein, 1987; Weinstein et al, 1987) and the Self-Regulated Learning Interview Schedule or SRLIS (Zimmerman and Pons, 1986).

For instance, the LASSI examines strategic learning at a general level, e.g. the study of a degree or diploma, whereas the MSLQ examines learning at a more specific level of the courses that comprise a degree or diploma. This level of scrutiny offered by the

MSLQ allows researchers not only to examine differences between students but also how a particular student may differ in the study of a number of courses that comprise their academic studies.

The other measure that was also considered was the SRLIS, a framework originally developed to study the strategic behaviour of high school students. However, since the programme of research associated with this thesis would focus on a population of adult learners, it was decided not to use the SRLIS.

The next section of this chapter examines learning strategy research in terms of distance education; exploring how the models of behaviour and learning outlined so far apply to this population of learners.

2.5. Learning strategies and distance education

Keegan, (1990) distinguishes conventional university education, which he claims is oral and group based, from distance education by proposing that it 'shatters the interpersonal communication of face-to-face provision and disperses the learning group throughout the nation' (p3). Distance education has its beginnings in university correspondence courses of the 1800's but the founding of the Open University in Great Britain in 1969 marked a revolution in the delivery of this type of course. For the first time various technologies, including audio cassette, radio and television programming, were used to supplement print based materials (McIsaac and Gunawardena, 1996). This model of course delivery proved immediately successful and today forms the basis of many distance education programmes around the globe.

The Open University has continued to concentrate on the provision of courses at a distance, but increasingly, traditional universities, recognising the economic benefits to this approach, are beginning to develop and offer distance programmes alongside the on-site study of courses. However, as Keegan points out the two approaches are quite distinct. They are not purely different modes or methods of delivery but rather distinct systems of education. Up until the 1960's, distance education, whilst successful, lacked a theoretical basis that determined what made it different from, but as successful, as traditional education (McIsaac and Gunawardena, 1996).

Keegan (1990) has identified a number of theories that have formed the basis of modern distance education theory. They range from understanding the independence afforded by this type of education to its similarity to industrial production processes. A common feature of these theories was that they specified various social factors and learning advantages that made distance education a distinct discipline. Another shared quality was their focus on the process of instruction rather than the learning experience of the

student. In part, this learning experience has been addressed by researchers who have examined the learning strategies of distance learners. This research has generally found that models and measures of strategic behaviour initially developed from populations of students studying at traditional universities in the USA applied just as well to distance education students across the globe.

For instance, the LASSI has been used by Köymen (1992) who found that distance and traditional university students in Turkey studying the same course had similar strategy scores. Olgren (1996) has investigated the nature of information processing strategies used by distance students and found that this behaviour could be categorised according to the model proposed by Weinstein and Mayer (1985). Olgren (1998) has further claimed that research into the learning strategies of distance students can benefit course design for distance learning in several ways. Firstly, such research can draw attention to the quality of learning outcomes and the components involved in achieving that outcome. Learning strategies can also be used to assess why individual learners may not respond to the instructional events as intended. Finally, the conceptualisation of strategies provides a set of tangible components to be considered in aspects of course design intended to promote content learning, use of established skills and their development.

The work of Small (1986), however indicates that researchers and course designers ought to consider that learning strategies may differ between distance learners in different community settings. In a series of interviews conducted with students in both rural and urban communities in Western Australia, Small found a number of differences between these two groups. These included the fact that rural learners were more likely to report that their formal schooling was a positive experience compared to the urban learners. In terms of their study practices, both groups used similar information

processing strategies, although rural students were more disciplined and motivated to study than their urban counterparts. That is, they made greater use of support strategies.

Bernt and Bugbee (1993) claim that such support or secondary strategies have been the main focus of learning strategies research in distance education. In their own research they tried to examine both primary and secondary strategies used by students on a business studies related course. This distinction between strategies reflects Dansereau's (1978) specification of primary strategies as essentially information processing strategies and secondary strategies as support strategies.

Bernt and Bugbee examined the study practices of three groups of students: those who generally gained high passes, those with low passes on courses and those that failed. The students' practices were examined using a specially designed questionnaire, based on a survey of items included in a number of instruments designed to measure the strategic behaviour of traditional university students. The findings from this questionnaire indicated that a combination of both these primary and secondary strategies contributed to the academic performance of distance learners.

Specifically, Bernt and Bugbee found that students with high scores were more successful in their use of support strategies. However, there was little difference between the three groups in terms of their information processing behaviour, their use of primary strategies. Bernt and Bugbee, like the other authors documented in this section, urge course designers to be aware of differences amongst students and make course design sensitive to those differences.

Summary

This chapter has so far highlighted theory and research indicating that students differ in the way they approach academic learning tasks; that this approach can be considered using a variety of constructs and that an increasingly favoured construct in determining how students differ in their approach to learning and studying is the learning strategy. The chapter has also presented evidence that learning strategies models that account for the study practices of students at traditional universities can also account for the behaviours and processes of students studying at a distance. The intention of the review presented thus far has been to outline a case for the importance of examining the learning strategy construct and what learning strategies tell us about students learning and study behaviour.

So far, however, this chapter has discussed the approach taken by students, be it style or strategy, in terms of traditional instructional methods (e.g. the lecture and tutorial) and materials (e.g. textbooks and text-based course materials). The next section of this chapter examines the literature relating to learning strategies and learning with computers. The section provides further support for this thesis, by not only identifying a need for research examining the computer-based learning strategies of research, but by also outlining two main criticisms that can be made of previous research. One criticism is that whilst previous research has examined the learning strategies students adopt when learning with computers, the findings of this research have lacked scope in terms of the strategies examined by concentrating on particular aspects of computer-based behaviour. The other is that the process of enquiry has often ignored what is known about the strategies students use when exposed to traditional learning methods and materials.

2.6. Learning strategies and computer-based learning

Sweany et al (1996) highlight the fact that very little research on learning strategies has occurred with multimedia tools. Instead, much of the research that has sought to determine the nature of learning strategies has focused on well-structured domains such as the reading of printed text, note-taking, maths and science (Chang and McDaniel, 1995). The strategy constructs that have resulted from research into computer-based learning have generally been used in two ways by researchers interested in the learning experience of students using CAL tools.

Some have suggested how particular learning strategies could be incorporated into system design to facilitate greater success or deeper learning. For example, Park (1995) reports on how strategies determined as particularly effective in non-computer-based learning environments could be implemented in computer-assisted instruction (see also Jonassen, 1988). Other researchers have focused on identifying learning strategies as indicators of students' success or failure in using a particular CAL system (Davidson-Shivers, Rasmussen and Bratton-Jeffery, 1997). There are, however, two main trends that can be identified in the emerging literature relating to learning strategies and computer-assisted learning. One trend is to propose a set of strategies to account for the overall use of a computer-assisted learning programme. The other trend is to concentrate on the strategies related to a specific aspect of using a computer-based learning environment, most often search or navigation related behaviours.

General computer-based learning strategies

Lyman (1998) identifies a series of issues related to learning with the World Wide Web and the learning strategies of students that may as easily refer to computer-based learning in general. One conclusion is that an emphasis has been placed on what the

environment has to offer, and not how learners can productively use its various resources to learn effectively. A more important conclusion Lyman makes is that effective learning is contingent on the extent to which particular learning strategies allow a series of objectives to be achieved. These objectives include: knowing when there is a need for information; identifying information needed to address a given problem or issue; locating, evaluating and organising information; and using information to effectively address the problem or issue at hand.

According to Lyman, the need for such skills in the context of Web-based learning is important considering that the network of information and sites is extensive with many users unaccustomed, and in many cases anxious, when it comes to the Web's exploration or potential. The same points could also be made of other computer-based learning systems that are not Web-based. That is, for most users, the organisation of information is different to that which they are used to in print-based resources and similarly users may be inexperienced or anxious about using such media.

Lyman further argues that to neglect an understanding of learning strategies whilst using the Web is to undermine the potential of the medium to meet the multi-faceted goals of the learner. This argument, again, could also be directed towards other computer-based learning environments aside from the web.

Typically, investigations of students' computer-based learning strategies occur in terms of Hypermedia systems that are predominantly resource based. Saunders (1998), however, has investigated the learning strategies of students in relation to an online system that incorporates computer-mediated communication. This study is the only work identified that has examined the computer-based learning strategies of distance education students.

The system investigated by Saunders was developed for a distance taught post-graduate course and allowed a group of thirty-seven students to participate in group discussions, exploration of the web and online communication with instructors, peers and experts. From interviews with students Saunders identifies three main strategies used in operating and meeting the needs of the course with the system. Two of the strategies were considered to be cognitive strategies and included *managing the computer environment* (i.e. mastery of the technology, utilising components of the system); and *management of personal resources* (i.e. investment of effort and management of time spent with the system). An affective strategy of *interpersonal networking* was also identified which was characterised by the development of personal relationships with other system users in order to fulfil the course requirements.

Arguably, the strategies that Saunders identifies could be better described as resource management strategies rather than cognitive or affective strategies. That is, the strategies describe how students adapt to using the environment and how they manage both the resource and their time using the resource. Rather than this being a pedantic criticism it identifies a greater shortfall of the research that attempts to examine students' computer-based learning strategies. That is, such research appears to lack an adequate consideration of strategy models proposed in terms of traditional learning materials. This criticism has already been made of Saunders work but it could also apply to Lyman's proposal that effective learning with the Web is contingent on how well learning strategies allow a particular set of objectives to be achieved. While Lyman is quite specific about the objectives that learning strategies should be targeted towards there is no elucidation about what particular learning strategies the student would adopt or use to achieve these objectives. The objectives Lyman proposes could be characterised as cognitive learning objectives that would accordingly be best realised

by cognitive strategies. However, the findings of the research reviewed in Section 2.4 of this chapter is quite explicit that a series of motivational, cognitive and resource management strategies interact together in the learning experience of the student, however successful that experience may be.

These criticisms lead to two conclusions about what little previous research that has attempted to account for the overall computer-based learning experience of students. Firstly, it appears to have lacked sufficient understanding of the strategies students use in their everyday study and the how these strategies interact. Secondly, the findings of this previous research also indicate a fairly limited set of strategies proposed to account for the learning behaviour of students learning with computers.

Specific aspects of the computer-based learning experience and learning strategies

This section explores another trend in the computer-based learning strategies research. This trend is to focus on strategies students use when performing specific activities, commonly searching and navigation, in the computer-based learning environment. Hill and Hannafin (1997) have attempted to gain a preliminary understanding of the Web's potential by examining users exploration and navigation behaviours in terms of cognitive strategies. The strategies that Hill and Hannafin explore were derived from a meta-analysis of the literature in multi-disciplinary fields including instructional design and information systems. They identify a series of strategies that are likely to have an impact on learning that occurs using a system that is learner-centred, what the authors term an open-ended learning environment (Hannafin, Hill and Land, 1997). Such a system caters to the individual demands of the user yet lets users work with information that is comparable in terms of difficulty and complexity, the intention being that different learners achieve a similar learning outcome.

The work of Hill and Hannafin provides an example of where an investigation of computer-based behaviour has been framed by what is known about students' learning behaviour with traditional learning materials. However, their study centred on a small number of users who allowed free-reign to search the Web for information related to a personal interest and not an academic related task. Another criticism of Hill and Hannafin's work is that they began with a set of strategies they drew from research on students' learning experiences with traditional course material and then tried to map computer-based learning behaviour on to these 'traditional strategies'.

Chang and McDaniel (1995) have also examined search-related behaviours in information rich computer systems but have concentrated on the identification of various search strategies. Specifically, four search strategies were reported in the study that ranged from the random to the highly directed. These included: *the aimless wanderer*, where the search was random, the system was explored but there was no detectable goal or purpose to the search; *the fact retriever*, where the search was driven by interest and isolated but overall by the need to gain concrete facts; *the casual investigator*, search motivated by a series of limited specific questions with little attempt to integrate results into broader understanding; and *the integrative analyst*, characterised by an attempt to arrive at a broad understanding of the subject and develop explanatory themes. Chang and McDaniel report that these could be linked to various levels of understanding, where generally deeper understanding was achieved by the fact retriever and integrative analyst searcher types.

In view of the work of Verheij, Stoutjesdijk and Beishuizen (1996), one criticism of studies that have examined search strategies appears to be how valid the search or learning task is in the context of university level study. In their study, Verheij et al examined the search strategies of psychology undergraduates using an introductory

psychology hypertext system. The system contained a series of screens that could be accessed either in a linear fashion, or using a map of the concepts and screens available. The students were assessed as having either a deep or surface learning approach and asked to perform two common academic tasks using the system: carry out a search for a particular concept and prepare for an exam using the system. In the study Verheij and his colleagues explored whether students with different learning approaches adopted different learning strategies in using the system and whether these strategies were constant over the two tasks.

The findings from the study revealed three main strategies for going through the system: map, linear and text-relation. The *map* strategy was characterised by constant use of the map facility that provided an outline of the system's content. The *linear* strategy was characterised by students following a sequence of screens in a linear fashion. The *text-relation* strategy was characterised by students moving about the system following a path of related information.

The study revealed that students' strategy for the exam preparation task was not related to their overall learning approach. However, in the search task, a deep approach was associated with the use of the map strategy, whilst the surface approach was associated with the text-relation strategy. Verheij et al also found that deep processors were likely to adapt a strategy to suit the task in hand, whilst surface learners were more likely to maintain using the same strategy for both tasks.

Schroeder and Grabowski (1995) identify similar search strategies to those of Verheij et al, although they further distinguish between active or conscious exploration strategies and less conscious, passive movement in a system. Conscious strategies are observed when the students attempt to study the concepts and their relations in the learning domain. This behaviour is characterised by the pursuit of a particular topic or the

exploration of information in terms of its hierarchical organisation in the system. This type of strategy is often associated with extensive use of a map or index feature of the system. Passive strategies include basic exploration of the screens in the order that they appear. Where the map of the system is presented as a central node with a series of surrounding satellite sub-nodes, a passive strategy also includes a clockwise exploration of the sub-nodes starting at the upper left or top sub-node which stems from Western reading patterns. Schroeder and Grabowski found that novice hypermedia users were more likely to adopt passive strategies.

In examining the behaviour of both novices and experts in a hypermedia environment, Astleitner and Leutner (1985) identified a series of component processes or strategies, which influenced the reported choice of nodes within what they reported as a medium sized system. Three processes were identified including *attaining a temporarily activated goal*, or the search for a particular piece of information in the system; *ensuring spatial orientation*, that is, being able to revisit a node from anywhere in the system defined in much the same way as the Hill and Hannafin strategy of perceived orientation; and *acquiring knowledge through the meaningful integration of information.*

Astleitner and Leutner also report on a series of problems associated with each of these processes. The first of these, distraction, is caused by vast quantities of information within the system and consequently leads to relevant or important nodes being ignored. Disorientation is another common problem, where the learner is essentially lost in the system and is unable to retrace their path through the information they are navigating. A final problem is one of cognitive overload where a high demand is placed upon the processes of attention and storage. These problems, the authors suggest, may be overcome by the application of learning strategies that have proved successful with

traditional teaching methods, for instance including index systems, summaries or objectives.

The work of Verheij et al, Schroeder and Grabowski, Astleitner and Leutner, detailed above, faces another criticism of the work related to search and navigation related strategies. The work of researchers in this area, whilst providing a detailed account of how learners search or navigate a system, fails to acknowledge the full context in which that behaviour occurs. That is, there is only partial, or often no, consideration of why this behaviour results, how it relates to the students' efforts in trying to manage their time and the resources, and also, most importantly, what they do with the information they retrieve or encounter.

When we examine the work relating to search and navigation based strategies a series of methodological criticisms come to light along with issues of how relevant the findings are if they concentrate purely on search or navigation behaviours and not the full context in which these supposed strategies occur.

2.7. Chapter summary

The aims of this thesis are to examine the learning strategies students use when learning or studying with computers and the extent to which they differ from traditional learning strategies. The need for an investigation of this topic was identified on the basis that use of information and computing technology is a progressively more common feature of the university curriculum yet little is known about the range of learning strategies students use with this teaching medium.

This chapter has attempted to highlight this neglected area of research and addressed a number of important questions associated with the aims of the thesis:

- What developments have there been in our understanding student learning in terms of learning strategies?
- How does our understanding of learning strategies used by students at traditional universities apply to the distance education setting?
- What has previous research told us about students' computer-based learning strategies?

This chapter identified a number of developments in our understanding of student learning. These included the move from cognitive style to learning style and the modern shift from learning style to learning strategies. The main advantage of viewing learning in terms of strategies is that this conceptualisation is concerned with the learning processes of students not the classification of individuals.

The way we have come to think about the nature and role of strategies has evolved over the last thirty years. Early on, strategies were considered only in terms of information processing (Dansereau, 1978; Rigney, 1978) but increasingly strategies have been

considered to have a far greater role in the learning experience of students (Pintrich, 2000). A more modern rationalisation of a learning strategy is that of a responsive behaviour, or motive on the part of the student to a particular learning context (Riding and Rayner, 1998). It can be influenced by the general approach of students to learning, the task or the domain and therefore different levels of strategic behaviour can be in use by the student (Kirby, 1984; Biggs, 1984).

Measures of strategic behaviour consider a particular strategy to differ in terms of the extent to which it used (e.g. the MSLQ, Pintrich, Smith, Garcia and McKeachie, 1989) but a strategy can also be comprised of a sequence of processes (Dansereau, 1985). The use of strategies is also increasingly understood to be influenced by the perceptions the learner has about their own ability to complete a task and achieve a particular learning outcome (Zimmerman, 1986, 1989, 1994). Central to behaviour (be it a mental process, motivational or a physical activity) being described as a strategy is that it is observed in, or reported by, a number of students in the population being studied.

The research on learning strategies is mainly an American endeavour that focuses on the learning experience of students at traditional colleges or universities. In this thesis the population consisted of distance learners. The research on learning strategies used by this group of learners is modest compared to that carried out with traditional university students. What research has been carried out considers an understanding of learning strategies used by distance learners important for similar reasons – understanding how students learn can improve their learning. Research in distance education has also provided models of learning behaviour that are generally similar to models that emerge from research with students at traditional universities (e.g. Olgren, 1996; Bernt and Bugbee, 1993).

In the past, researchers have attempted to examine the computer learning strategies of students but this research has tended to focus on search or navigational strategies (e.g. Chang and McDaniel, 1985; Verheij et al, 1996) or has been limited in the scope of the strategies examined (e.g. Lyman, 1998; Saunders, 1998). Astleitner and Leutner (1995) propose that an examination of learning strategies in the use of computer-based learning environments has largely been neglected, yet would offer a number of benefits. An important benefit would be the development of a reliable standardised measure of the different factors relevant to this way of learning. Such a measure is currently lacking, as is the agreement over what behaviours to consider relevant to the learning experience in a computer-based learning environment.

Another issue is that these studies have failed to examine the extent to which these computer-based strategies differ from traditional learning strategies. This thesis attempts to widen the scope of strategies explored and examine the extent to which computer-based strategies differ from traditional learning strategies. The next chapter details the first step in this research process, the selection and testing of a traditional model of learning strategies against which computer-based strategies were eventually compared.

Chapter 3

STUDY I: EXAMINING THE RELIABILITY OF THE MOTIVATED STRATEGIES FOR LEARNING QUESTIONNAIRE.

3.1. Introduction

The previous chapter examined the different ways in which educational researchers have considered students' learning strategies. The chapter also explored the impact on behaviour and learning outcome that results from learning with computers. From this research it emerged that whilst previous research has attempted to investigate the learning strategies students use in computer-based environments, this has been limited in scope, often concentrating on information processing or search behaviours. This previous research has also failed to examine whether students use similar strategies in their study of computer-based learning materials and traditional learning material.

At present there exist a number of learning strategy models that relate to the study of traditional educational material, however, none of these consider or account for student behaviours or processes when learning with computers. Furthermore, these frameworks have often been developed with college student populations studying at traditional universities in the United States.

This chapter reports on a study that aimed to examine whether a learning strategy questionnaire, developed in the US for traditional college students, retained its reliability when tested in the UK with a population of distance learners. This study, Study I, was the first in a series of studies conducted as part of the thesis research. The remaining studies are outlined in the next chapter of the thesis that details the methodology of empirical research. Essentially, the intention of this thesis was to use an established model of learning strategy behaviour as the context against which to compare and interpret computer-based behaviour.

Another important element of this design was that the investigation of learning strategies had to take place in a real learning situation since strategic behaviour is influenced by, and dependent on, the context in which learning occurs (Alexander, 1995). To this end, a course at the Open University was chosen that made use of a

multimedia CD-ROM. The course, SD206: Biology, Brain and Behaviour, was offered jointly by the Science and Social Sciences faculties.

The Open University teaches courses at a distance yet established learning strategy measures have been developed with traditional college students in mind. The literature review of learning strategies in relation to distance education revealed that models of strategic learning based on traditional university study could account for the learning behaviour and processes of distance education students (e.g. Köymen, 1992; Olgren, 1996; and Bernt and Bugbee, 1993). However, the review revealed that there was no dedicated instrument available to examine learning strategies in this setting and no previous examination had occurred of students studying at a distance in the UK. Therefore, it was decided to use an established American questionnaire, designed to measure the learning behaviour of students in the traditional university setting, to examine the learning strategies of the distance education population studying in the UK. It was believed that if the questionnaire retained its reliability then its underlying strategy framework could also be assumed to be reliable. This framework could then provide a basis against which to compare and frame an examination of learning strategies specific to computer-based learning environments.

The learning strategies model and questions chosen were the Motivated Strategies for Learning Questionnaire developed by Paul Pintrich and colleagues at the University of Michigan (Pintrich, 1989; Pintrich, Smith, Garcia and McKeachie, 1989). There were two main reasons linked to the selection of this particular instrument. Firstly, the MSLQ has been well documented as a reliable measure of student learning, secondly, as discussed further on in this chapter, it was considered more sensitive to the course context than other measures such as the Learning and Study Skills Inventory or LASSI

(Weinstein, 1987; Weinstein et al, 1987) and the Self-Regulated Learning Interview Schedule or SRLIS (Zimmerman and Pons, 1986).

3.2. The Motivated Strategies for Learning Questionnaire (MSLQ)

This section details the background linked to the development of the MSLQ, the behaviours that the MSLQ measures and how the MSLQ incorporates the increasingly popular view of student learning as being self-regulated.

3.2.1. Background

In 1982 the University of Michigan offered a freshman (first year) introductory psychology course in Learning to Learn. The course aimed to combat underachievement in three main groups of students, anxious students, minority students and student athletes (see McKeachie, Pintrich and Lin, 1985). It was one of the first accomplishments of a still active programme of research into learning strategies across a range of courses at the university, and other institutions. It also marked the informal development of the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia and McKeachie., 1989). Since 1986, formal research into the MSLQ, learning strategies and learning has been carried out by the National Centre for Research to Improve Postsecondary Teaching and Learning at the University of Michigan.

McKeachie (1990), writing about the work carried out by the centre, detailed some of the beliefs that characterised the research programme from which a conceptual framework of strategies and the MSLQ eventually emerged. These included:

- the consideration and preparation of students as lifelong learners
- the notion that students construct knowledge on the basis of that which they already know
- the belief that the ability to remember and use what we are taught is dependent on the initial level of understanding we gain
- the view that human beings are inherently learning creatures but whose interest can become weakened when we question our competence

These beliefs and assumptions are reflected in the conceptual framework that underlies the MSLQ and the two main views about students' approach to academic tasks and learning that it incorporates (Pintrich, 1989). The first of these is a cognitive view of motivation and cognition. This view assumes learning is a cognitive activity influenced by particular motivations and information processing strategies that interact with one another. The second view incorporated into the framework is a socio-cognitive view of academic tasks, the notion of learning being an activity that is both determined and influenced by the environment in which it occurs.

In total, three main classes of behaviour are presented in the framework: motivational determinants of learning, cognitive and metacognitive strategies and, finally, resource management strategies. Each class of behaviour consists of a series of component behaviours. Since the early eighties these have been empirically investigated and have been rationalised in terms of a range of strategies measured by the MSLQ.

3.2.2. What the MSLQ measures

The investigation of these learner practices with more than a thousand students since the early eighties has led to a formalised version of the MSLQ (Pintrich, Smith, Garcia and McKeachie, 1993; Garcia and Pintrich, 1996). A large proportion of learning strategy questionnaires and inventories measure behaviours and processes at what could be considered a general level, the overall study of a degree. However, the theoretical model of learning upon which the MSLQ is based emphasises that the learner is sensitive and capable of adapting to the specific features and demands of a particular learning situation. Therefore, the MSLQ is designed to measure learning behaviour and processes at a course specific level. The award of degree is based on the study of a number of courses: these are referred to as modules or credits in various international systems of tertiary education (Rowe, 1989). According to the theoretical model underlying the MSLQ, the extent to which students use particular strategies will differ

between the various courses taken whilst completing a degree and can also differ between disciplines (VanderStoep, Pintrich and Fagerlin, 1996; Wolters and Pintrich, 1998). For a single student, the variation between learning strategies for different courses may be minimal or significant depending on a multitude of factors personal to the student.

The questionnaire comprises 81 items, each scored on a seven point Likert scale with ratings ranging from 'not at all true of me' (score of 1) at one extreme to 'very true of me' at the other (score of 7). Motivation is measured by six subscales: *intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance,* and *test anxiety*. Learning strategies are measured by nine subscales: *rehearsal, elaboration, organisation, critical thinking, metacognitive self-regulation, time and study environment management, effort regulation, peer learning* and *help-seeking*.

The current study used all fifteen subscales. However, the measures are designed to be modular, that is, either all fifteen subscales or a selected few can be measured. Subscale scores were constructed from the completed questionnaire by taking the mean of the items that make up the scale. The questionnaire also contained a series of reverse items; the ratings of these negatively worded items were reversed before a subscale score could be established. Table 3.1 indicates the components and practices conceptualised for each class of behaviour, along with how they appear in the MSLQ as subscales. In recent years this

Table 3.1. The conceptual framework, components and strategies underlying the MSLQ

Class	General Components	*Components/* Strategies	Definition	MSLQ Strategies
Motivation	**Value** Beliefs about the importance and value of the task, essentially the question: Why am I doing this task?	**Student Goal Orientation**	Can be intrinsic (linked to mastery, learning, curiosity) or external (linked to grades, awards or approval).	**Intrinsic Goal Orientation** **Extrinsic Goal Orientation**
		Task Value	Including perception of the importance of the task, interest in the task, usefulness or utility of the task	**Task Value**
	Expectancy Beliefs about personal ability or skill to perform a task, essentially the question: Can I do this task?	**Control Beliefs**	Refers to students' beliefs that their efforts to learn will result in positive outcomes that contingent on one's own effort.	**Control of Learning Beliefs**
		Self-Efficacy Beliefs	Judgements about ability to accomplish certain goals or tasks, regarded as being specific to situation or domain	**Self-Efficacy for learning and performance**
		Expectancy for Success Beliefs	Beliefs about the probability of success (or failure) on particular task	
	Affective Personal feelings or emotional responses to a task, along with evaluations of self.	**Test Anxiety**	How performance or more specifically use of cognitive strategies, can be disrupted by anxiety.	**Test Anxiety**
		Self-Esteem	Influence of trying to maintain and promote positive self image	
Cognitive	**Cognitive** Draw on Weinstein and Mayer's (1986) notion of learning strategies, focus on information processing and handling	**Rehearsal**	Involves reciting or naming items from a list to be learnt, can include notetaking as one reads and underlining sections in a book. Can be considered a surface strategy	**Rehearsal**
		Elaboration	Helps store information in long-term memory by building internal connections between old and new information. Deep learning strategy	**Elaboration**
		Organisation	Selection of pertinent information and appreciation of connection between aspects or parts of the information to be learnt	**Organisation** **Critical *Thinking***
	Metacognitive Refers to awareness and control of cognition. Comprises three general processes: planning, monitoring and regulating.	**Metacognitive**	Awareness, knowledge and control of cognition.	**Metacognitive Self-Regulation**
Resource Manage-ment	Assist students in *managing environment* and the resources available. Essentially allow students to adapt to demands of situation and adapt environment to suit there own needs	**Time-management**	Refers to the students' regulation of their time and study environment. Scheduling of time can vary between specific tasks and larger periods of time.	**Time-management**
		Study Environment	Selection of a particular study environment that avoids distraction.	**Study Environment**
		Effort Regulation	Refers to students' ability to control their effort and attention in the face of distractions and uninteresting tasks. It is important in that it signifies commitment and also regulates the continued use of learning strategies	**Effort Regulation**
		Support of others	Refers to the management of support from others, including peers and instructors. Dialogue can help a learner clarify course material and reach insights one may not have attained on one's own.	**Peer Learning** **Help Seeking**

conceptualisation of behaviours and practices has contributed to part of a larger framework of self-regulated learning (Pintrich, 2000).

3.2.3. The MSLQ and self-regulation

Pintrich and DeGroot (1990) propose that self-regulated learning refers to the use of metacognitive strategies, cognitive learning strategies and the management of effort and found these practices were directly implicated in the academic performance of 12-year-old students. They also found that aspects of motivation, specifically self-efficacy and intrinsic motivation, were linked to the control and use of these practices. These aspects also emerged when Pintrich and Garcia (1991) examined the study practices and behaviours of college students.

In light of these findings, Pintrich, Wolters and Baxter (2000) offer a view of self-regulated learning as a construct that includes the monitoring, control and regulation of cognition along with motivation, perceptions of self and effort. More specifically, they view self-regulation as a set of ongoing activities that enable the individual to adapt and alter their learning behaviour to meet the needs of the learning domain/task. These activities include planning or learning goals; the selection and use of strategies; allocation of resources (time, effort, pace of learning) and volitional control (control and regulation of motivation, emotion and environment). This view represents a move away from determining the nature of learning strategies towards establishing their role alongside a number of factors that are linked to the learning experience of students (Zimmerman, 1994).

Furthermore, Pintrich, Wolters and Baxter (2000) indicate that measures of learning strategies are considered measures of self-regulation and an increasingly important issue is the extent to which these measures relate to theoretical conceptions of student learning. These authors consider some of the major issues that arise from the comparison of three popular measures of self-regulation and learning strategies: the

MSLQ, LASSI and the SRLIS. The observations they make support the use of the MSLQ questionnaire and framework in this thesis research.

In comparing the two self-report instruments, the MSLQ and the LASSI, the authors point to an important difference in the theoretical assumptions about the nature of self-regulation underlying their development. The LASSI emerges from a domain general perspective, i.e. what students generally do in their approach to academic learning. The MSLQ, on the other hand, arises from a more domain specific view, it examines learning at the course level. This was highlighted in Chapter 2 as the reason why the LASSI was not selected as the learning strategies measure in the programme of research associated with this thesis.

The SRLIS has its origins in the study of high school students (Zimmerman and Pons, 1986; Zimmerman, 1986, 1989). It uses an individual interview format to ask students about study and learning in specific contexts including written assignments, classroom discussions and study at home. The responses are then categorised into one of fourteen categories. The MSLQ provides what the authors consider a reasonable match to its underlying theoretical model on the basis of findings from confirmatory factor analysis (Pintrich et al, 1993).

It was reported in Chapter 2 that the SRLIS was not selected as a suitable measure of learning strategies for the thesis research due to its origin and exclusive use in high school level education. However, further support for the decision not to use this measure also comes from the fact that the categories of the SRLIS are based on a specific theory of self regulation (Zimmerman, 1989). Pintrich, Wolters and Baxter argue that the strategies in the theoretical model become the basis of extracting strategies from the reports of students collected in interviews. Thus, findings that

originate in this fashion may make the theoretical model more valid than post-hoc rationalisation of the findings.

Pintrich, Wolters and Baxter accept that all three of these measures provide insight into the control and regulation of learning. However, they concede that for all three techniques the full extent of personal monitoring, or metacognition, remains a more difficult component of the learning process to measure.

Of the comparisons made the MSLQ emerges as the more reliable and valid measure of learning strategies and self-regulation behaviour in the traditional university setting. The remainder of this chapter details how the internal and external reliability of the MSLQ were investigated in the setting of university level distance education.

3.3. Method

3.3.1. Design and Procedure

Approximately half the students (N=471) on the course Biology, Brain and Behaviour (course code SD206) were sent two questionnaires between June and September of 1998. This was the course for which the CD-ROM investigated in this thesis had been designed.

The first of the surveys, Questionnaire 1 (Appendix B), comprised two parts. Part A comprised a short list of general questions about the course. These included the amount of time spent studying the course and whether the CD-ROM featured as part of the study of the course. The purpose of this part of the questionnaire was to gain a general insight into students' thoughts about studying the course including their reasons for choosing it as part of their studies. This part of the questionnaire also served to identify those students using the CD-ROM and the reasons why other students chose not to use it.

Part B consisted of a modified version of the MSLQ intended to make it relevant to the distance learning setting. Garcia and Pintrich (1996) suggest that the questionnaire be completed during the meeting time of the class with the instructor, notes, materials and textbooks present also. They claim that such cues help stimulate the respondents to think about their actual beliefs and their behaviour for that course, thereby increasing accuracy. In the present study, since students were studying the course at a distance, each question incorporated the course code (SD206), the common referencing term for the course being studied. It was intended that this tactic would direct the responses of students to the course in question in the absence of the cues suggested by Pintrich and Garcia. Also, changes were made to a number of questions in an attempt to make the terminology (e.g. class, instructor) more appropriate to the setting students are familiar with whilst studying an OU course (see Appendix A for original version of MSLQ).

The questionnaire was sent to more than half the students on the course approximately halfway through their study of the course at a time when a routine in study behaviour would be likely to have been established. The aim of this posting was to examine the internal reliability of the questionnaire. Students who completed this questionnaire were asked to indicate whether they would agree to be contacted again as part of a piece of ongoing research. Those who agreed were sent the second questionnaire.

Those students who completed Questionnaire 1 were also asked to indicate whether they wished to be contacted again and contribute to the ongoing research and those who agreed were sent Questionnaire 2 (Appendix C).

Questionnaire 2 also comprised two parts. Part A was the modified version of the MSLQ. Part B consisted of a series of questions intended only for those students using the CD-ROM. This second part of the questionnaire was intended to provide an initial insight into the experience of using the CD-ROM. It was adapted from a survey of an earlier version of CD-ROM sent to students following the same course in 1996 and 1997 (Kirkwood, 1997, 1998). This survey was sent in August of 1998, followed at two fortnightly intervals with reminders. The aim of this posting was to examine the external reliability of the questionnaire by comparing the responses of the same students to the both postings of the survey.

3.3.2. Sample

Geographically, students studying with the Open University in Great Britain belong to one of thirteen regions and are allocated a tutor within their regional area. In 1998, throughout these regions, 900 students were registered to study the course. In this study, the sample comprised students from the seven regions in the south of Great Britain (regions 1, 2, 3, 4, 5, 6 and 13). Questionnaire 1 was sent to the entire student population registered on the course in those regions, 471 students in total. Following the

reminders sent to students 306 of the first questionnaire were returned. Of those that responded, 82 were male (27.5%) and 222 were female (72.5%). This sample ranged in age from 21- 81, with an average age of 38.14 (SD 9.33). From this set of students 257 agreed to be part of the ongoing research project. All of these students were sent Questionnaire 2, and after two reminders this was completed and returned by 96 students. Of those who responded to the second questionnaire, 25 (26%) were male and 71 (74%) female. The respondents ranged in age from 21 - 67 with an average age of 38.9 (SD 8.92). Of the 96 that responded, 45 (47%) reported using the CD-ROM.

3.4. Findings

This section concentrates on the findings from the MSLQ parts of the two questionnaires sent to students in Study I and outlines some of the findings from the other sections of the questionnaires.

3.4.1. Questionnaire 1

In Part A of Questionnaire 1 the questions students were asked to include how many hours they typically spent studying on the course and whether they used the CD-ROM as part of their studies. Approximately three-quarters of the students reported spending more than seven hours in a typical week on the study of the course (76%, n=231). A more detailed picture of study time in an average week is given in Figure 3.1.

In terms of using the CD-ROM, approximately two thirds of students reported that they either were using it or intended to use it at a later point in the course (63%, n=193). The main reason given for not using the CD-ROM was a lack of access to a machine with a CD-ROM drive (n=76), Additionally, seventeen students reported not using the CD-ROM because they preferred to study using traditional course material.

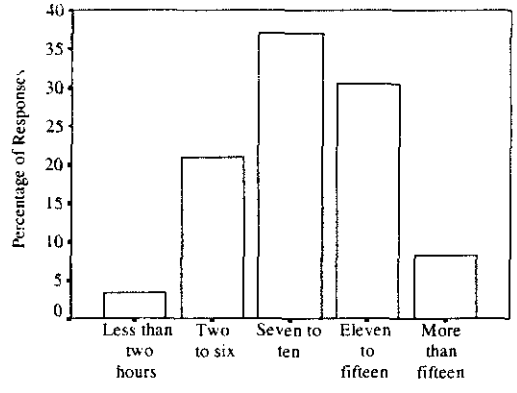


Figure 3.1: Hours spent studying on the course in an average week

The remainder of this chapter examines the findings from the MSLQ and the students on the distance education course Biology, Brain and Behaviour at the Open University (UK). These results are discussed with reference to the students as a group, but it should

be noted that learning strategies are considered to differ between individuals and so any generalisations made should be considered with some caution. In interpreting the subscale scores Pintrich, Smith, Garcia and McKeachie (1989) suggest that a score of four or above is considered a generally high score and is better than a low score of three or below. Pintrich et al also suggest that if the scores of an individual student are below three on six or more of the cognitive and resource-management strategies combined then academic interventions or counselling should be considered for that student.

Comparing the strategies is not vital to establishing the reliability of the MSLQ but it serves to offer an insight into the learning experience of the students in their study of the course SD206. Furthermore, aspects of this experience could be reflected in the use of the CD-ROM and emerge in the findings from later studies.

Table 3.2: MSLQ subscale scores (Mean and St.Dev)

	All students		Students responding to both surveys			
Subscale	1st Posting N=306	*St.Dev*	1st Posting N=96	*St.Dev*	2nd Posting N=96	*St.Dev*
Intrinsic Goal Orientation	4.72	*1.11*	4.71	*1.13*	4.64	*1.17*
Extrinsic Goal Orientation	4.21	*1.37*	4.31	*1.37*	4.09	*1.38*
Task Value	5.34	*1.04*	5.40	*.96*	5.16	*1.10*
Control Beliefs about Learning	5.01	*1.26*	4.87	*1.28*	4.93	*1.18*
Self Efficacy for Learning and Performance	4.05	*1.28*	4.10	*1.30*	4.03	*1.27*
Test Anxiety	4.27	*1.46*	4.26	*1.45*	4.17	*1.35*
Rehearsal	3.72	*1.34*	3.79	*1.35*	3.59	*1.31*
Elaboration	4.39	*1.08*	4.58	*.99*	4.18	*1.14*
Organisation	4.34	*1.39*	4.57	*1.46*	4.27	*1.34*
Critical Thinking	3.60	*1.30*	3.55	*1.31*	3.51	*1.31*
Meta-Cognitive	4.10	*.84*	4.14	*.78*	3.94	*.82*
Time and Study Environment	4.57	*1.16*	4.67	*1.12*	4.41	*1.22*
Effort Management	5.10	*1.17*	5.24	*1.12*	4.94	*1.34*
Peer Learning	2.12	*1.24*	2.11	*1.21*	2.08	*1.13*
Help Seeking	2.34	*1.30*	2.37	*1.35*	2.29	*1.22*

Table 3.2 presents the mean subscale scores for all fifteen subscales for all 306 students who responded to Questionnaire 1 and those students who responded to Questionnaire 2. In terms of Questionnaire 1, the mean scores for the motivational subscales suggest

students were generally motivated to do well on the course. The relatively high levels of intrinsic goal orientation and task value link this motivation to an interest in the subject matter. The high level of extrinsic goal orientation also indicates students being motivated by a need to achieve on the course. The high level of control belief indicates that generally students believed that they were the agents of their own success rather than chance or fortune. This belief is important as it is associated with more strategic and effective study (Pintrich et al., 1989). The level of self-efficacy indicated that generally students were confident about their success on the course and their learning outcome.

In terms of the cognitive learning strategies, the students on the course appeared to be making good use of deeper learning strategies. This is reflected in the moderately high scores for the organisation and elaboration strategies and with lower scores for the rehearsal strategy. Generally, the students reported a relatively low level of critical thinking - the application of previous knowledge or evaluation of information. This may be attributable to the subject matter of the course that is factual in content and places greater emphasis on the acquisition of knowledge. The help seeking and peer learning scores also appear relatively low. Again, this may be due to the particular context of the course and indicates that either very few opportunities on the course occur where students feel the need for help and support or the students do not often seek help. The latter explanation would appear more accurate considering the nature of OU study where students are separated from both tutors and peers for the majority of their study time linked to the course. The nature of this form of education, which relies upon the student being able to manage their time and commitments to the course, was also reflected in the moderate to high scores for resource and effort management strategies.

Table 3.3: Correlations amongst MSLQ subscales

	Intr	Extr	Taskv	Cont	Selfeff	Tanx	Reh	Elab	Org	Crit	Efft	Tstudy	Mcg	Hsk
Extr	.171													
Taskv	.589	.363												
Cont	.311	.116	.212											
Selfeff	.505	.267	.332	.452										
Tanx	-.044	.363	.108	-.087	-.278									
Reh	.046	.255	.250	.043	-.004	.253								
Elab	.280	.192	.378	.115	.174	.072	.353							
Org	.060	.146	.229	.061	.046	.131	.535	.402						
Crit	.450	.101	.349	.123	.323	.012	.118	.527	.173					
Efft	.389	.250	.409	-.021	.302	-.025	.200	.264	.262	.195				
Tstudy	.192	.200	.243	-.098	.127	.037	.275	.324	.230	.126	.560			
Mcg	.376	.189	.409	.196	.383	.062	.375	.538	.515	.525	.445	.413		
Hlsk	-.061	.108	-.001	-.123	-.014	.077	.096	.369	.048	.079	.029	.188	.131	
Prlrn	.022	.175	.060	-.019	.127	.092	.149	.290	.087	.120	.040	.103	.131	.640

NOTE – Intr: Intrinsic Goal Orientation; Extr: Extrinsic Goal Orientation; Taskv: Task Value; Cont: Control of Learning Beliefs; Selfeff: Self-Efficacy for Learning and Performance; Tanx: Test Anxiety; Reh: Rehearsal; Elab: Elaboration; Org: Organisation; Crit: Critical Thinking; Efft: Effort Management; Tstudy: Time and Study Environment Management; Mcg: Metacognitive Self-Regulation; Hlsk: Help Seeking; Prlrn: Peer Learning;

Correlating the strategies provides a more detailed picture of the learning experience for the course by indicating the dynamics between strategies in the same class and between classes (see Table 3.3). The correlations amongst the subscales mirror the correlations reported by Garcia and Pintrich (1996) in their study of American college students.

With the exception of the Test Anxiety subscale, all the motivation subscales were positively correlated with each other. The negative correlations between the Test Anxiety subscale and the other motivational subscales indicate that low levels of motivation would result in increased anxiety about assessment procedures. In relation to the cognitive strategies, most of the subscales also correlated positively with one another. Weaker correlations were found between the help seeking and peer learning subscales and the other subscales, both motivational and cognitive.

The correlations between the cognitive and motivational subscales were generally small. Pintrich and Garcia (1996) report that this is evidence of the constructs being orthogonal in their relationship to one another. That is, the motivation and cognitive subscales are types of subscales measuring distinctively different behaviours and processes.

3.4.2. Internal reliability

The aim of Study I was to examine the reliability of the MSLQ questionnaire and its associated framework. It was important to examine the reliability of the MSLQ since this was the first time that the MSLQ had been administered to UK sample studying at a distance. Secondly, the original instrument had been adapted to make it relevant to this context.

At this stage in the study, with the MSLQ completed only once by students, Cronbach's alpha was used to check the internal reliability of each subscale that comprised the instrument. What was being examined was the degree to which the different items that comprised each of the subscales were scored consistently. Cronbach's statistical procedure is commonly used as an indicator of internal reliability in psychometric with a measure of reliability can range between zero and one. A figure of .7 is generally accepted as a good indicator of reliability (Kline, 1993). Table 3.4 indicates a high level of reliability of the subscales ranging from .60 to .92 and little difference between the reliability of the scales reported by Pintrich amongst the British and American coefficients.

Table 3.4: Coefficient Alphas for Great Britain and the USA reported in Pinrich et al (1989).

	GB	USA
Intrinsic Goal Orientation	.70	.74
Extrinsic Goal Orientation	.68	.62
Task Value	.82	.90
Control Beliefs about Learning	.76	.68
Self Efficacy for Learning and Performance	.92	.93
Test Anxiety	.76	.80
Rehearsal	.66	.69
Elaboration	.65	.75
Organisation	.71	.64
Critical Thinking	.83	.80
Meta-Cognitive	.71	.79
Time and Study Environment	.73	.76
Effort Management	.60	.69
Peer Learning	.71	.76
Help Seeking	.73	.52

3.4.3. Questionnaire 2 – External reliability

The second posting of the questionnaire served primarily to examine the external reliability of the subscale, that is, the consistency of subjects' reporting of their own behaviour and processes over two testing periods. Correlating subscale scores from an initial testing and then re-testing of an instrument using the same sample of subjects can establish external reliability. Of the 306 students that returned the first questionnaire, 257 stated that they would have no objection to being sent the MSLQ again. Two months after the initial posting of the MSLQ the questionnaire was posted again to all 257 students. Ninety-six of the questionnaires were returned.

In comparing the 96 subjects to the sample who responded to Questionnaire 1, Table 3.2 indicates minimal differences in the mean subscale scores from the first posting of the questionnaire. There were some apparent decreases in the average subscale scores over most of the measures, between the first and second postings. However, these generally appeared to be minimal indicating at a crude level that the MSLQ has a good level of external reliability. More appropriately, external reliability is measured in terms of the correlations between subscales from the same sample over two testing periods. The

correlations between the subscales scores of the 96 students from the first and second posting are presented in Table 3.5. All the subscales on the MSLQ were shown to have good external reliability with correlation coefficients ranging from .53 to .86.

Table 3.5: Subscale correlations from first and second posting

Subscale	Correlation (rho)
Intrinsic Goal Orientation	0.68
Extrinsic Goal Orientation	0.77
Task Value	0.74
Control Beliefs about Learning	0.53
Self Efficacy for Learning and Performance	0.86
Test Anxiety	0.75
Rehearsal	0.72
Elaboration	0.61
Organisation	0.72
Critical Thinking	0.84
Meta-Cognitive	0.69
Time and Study Environment	0.82
Effort Management	0.74
Peer Learning	0.76
Help Seeking	0.77

3.5. Summary

This chapter examined the development and use of the Motivated Strategies for Learning Questionnaire or MSLQ and its relevance to modern notions concerning the self-regulation of academic learning. Compared to a number of other learning strategy and self-regulation measures the MSLQ emerges as one of the most reliable and valid instruments for examining learning in the traditional college setting of the US. The aim of the study reported in this chapter was to examine the reliability, both internal and external, of the MSLQ when measuring the behaviour of a population of distance learners studying in the UK.

The findings from both the questionnaires indicated a group of learners that were generally highly motivated to both complete and succeed on the course. Most students also reported making good use of what are considered cognitive strategies that lead to deeper levels of learning. Students also reported low levels of critical thinking, a finding that is consistent with the learning objectives of the course. That is, students were required primarily to learn the structures of the human nervous system and understand their functions and not necessarily evaluate critically a body of evidence.

The responses of students to Questionnaire 1 provided an examination of the internal reliability of the MSLQ. Each subscale demonstrated an acceptable, or in most cases high level of internal reliability. Internal reliability was measured in terms of each subscale in keeping with the analysis carried out by the team who developed the instrument. Therefore, the questions that comprised those subscales were analysed using Cronbach's alpha to determine to what degree they measured the behavioural construct.

The external reliability of the MSLQ was also examined in this study. This was achieved by correlating the subscale scores of students responding to both the first and second questionnaires. The high correlations that resulted indicated that the MSLQ had good external reliability. The findings from Questionnaire 2 also showed that the

learning strategies of students remained comparatively stable over a period of two months.

Study I demonstrated that both the internal and external reliability of the MSLQ was retained when the instrument was tested in the context of the UK distance education sample. Thus, it would be appropriate in the remainder of the research programme to use the conceptual framework of strategies underlying the MSLQ to frame the examination of students' computer-based learning strategies. The methodology associated with this research programme is detailed in the next chapter.

Chapter 4

METHODOLOGY

4.1. Introduction

The purpose of this chapter is to outline and provide a rationale for the research methods used to investigate the strategic behaviour of students. Initially the chapter explores the aims and objectives associated with this investigation and the formulation of these into a programme of research. It then presents an examination of the research methods and forms of analysis that were identified as suitable to fulfilling the aims of the research. The chapter ends by outlining how these methods were combined into a programme of research consisting of four studies.

4.2. Rationale

The aim of the empirical research carried out as part of this thesis was two fold:

- To determine what learning strategies students use when learning with computers
- To determine the extent to which students' computer-based learning strategies differ from the traditional conceptualisation of learning strategies

There were a number of practical issues associated with these aims that needed to be considered before a research plan could be formulated or methodology considered. An important consideration was that learning strategies are sensitive to the context in which learning takes place. Therefore, participants in the study would have to come from a course that also allowed students the opportunity to learn with a computer.

Since the start of its courses in 1970 the Open University has embraced a number of teaching tools, predominantly text based learning materials but also television/video programmes. Over the last two decades computer-assisted learning software, or courseware, has increasingly supplemented such formats. Most of the courseware developed at the Open University have been produced to supplement or complement science courses. One example, 'The Works Metallurgist' (see Tosunoglu et al, 1996)

has been designed to help students with problems experienced in interpreting phase diagrams. Another, 'the Driven Pendulum' (see Scanlon et al, 1997) assists students with their understanding of the physics of motion.

The Open University course, SD206 - Biology: brain and behaviour, is a relatively new addition to the range of courses that offer students the option of studying using a computer. Currently, students on the course are given the opportunity to study using a CD-ROM titled "the Human Brain". This course and the CD-ROM became the basis of the research carried out for this thesis.

Another important issue was how to measure the computer-based learning strategies of students. In the review of the literature presented in Chapter 2 it was concluded that current models and measures of learning strategies do not consider computer-based learning in their appraisal of the learning process. However, a number of reliable instruments have been designed to measure the learning strategies students adopt in their study of a traditional course and this provided the beginning of a solution to the problem of measuring computer-based behaviour. These instruments are often associated with a theoretical framework of strategies. Thus, if a chosen instrument was found to be reliable then its underlying framework could also be considered reliable. This chosen framework could then be used as basis for examining students' computer-based learning strategies. It would also provide a means of traditional study and learning processes to those adopted in learning with computing technology.

Thus, the research would comprise a programme of research that over a period of approximately two years would address a series of objectives. These objectives included:

- Gaining a measure of students' traditional learning strategies

- Demonstrating that this measure was reliable (especially important considering that the sample tested would be students in Great Britain studying at a distance rather than the population of college students at traditional American universities that most instruments have originally been developed for)
- Examining computer-based learning and study behaviour
- Comparing traditional and computer-based strategic behaviour

In addressing these aims, the programme of research adopted a survey approach, a traditional methodological approach commonly used in the investigation of learning strategies. The survey is a popular approach in general educational research where it allows an examination of conditions, standards and relationships between events using different research methods including interviews and questionnaires (Cohen and Manion, 1994).

Other research methods that were also considered included the use of case studies and focus groups. The case study can provide an understanding of specific events or situations and ideally draws on a number of sources of information not just self report evidence (Anderson, 1990). Throughout the programme of research the core interest was the experience of students using the CD-ROM with the research outcome being to report on that experience in a reliable fashion. In many ways the research programme incorporated case study research techniques such as interviews and qualitative data analysis. However, it would be incorrect to describe the research programme as a case study of the CD-ROM since it concentrates on the perspective of the student. What would have defined it as a case study would be an integrated approach including the views of the designers, course leaders, tutors. This approach was not taken because the research questions were quite specific in that they related solely to the experience of the

student users. The focus group, on the other hand, presented a more common difficulty associated with research in distance education in terms of the need to gather students in the same location at the same time. This approach was considered, though, because it can provide an advantage over the account given by an individual in an interview or that one individual's response to a questionnaire because the group dynamic can often lead to greater insight into a populations' experience (Anderson, 1990).

Instead the design of the research programme included semi-structured interviews carried out face-to-face and by telephone along with postal surveys that were utilised to ascertain the strategic behaviour of students. The survey has also been described as an attractive and efficient method of collecting detailed information from a sample of the target population, although a disadvantage is the selection of a representative sample (Anderson, 1990). In the latter stage of the programme, whilst students were interviewed about their use of the CD-ROM, they were also observed using the technology. Anderson indicates that one of the issues associated with self-report measures, such as interviews and questionnaires, is that the interviewee or questionnaire respondent will in some instances provide what they believe to be a response desired by the researcher rather than commenting on their actually experience. Observing students using the CD-ROM on their own computer offered the interviewer an opportunity to corroborate the reports of students with their actual behaviour. Cohen and Manion (1994) urge the educational researcher to adopt a disciplined note-taking approach when carrying out observation where notes are made as quickly as possible during the exercise and are as detailed as possible. However, in the event where observation was used in the research programme a different approach was adopted: the interviewer relayed out-loud to the subject what they had observed as it happened. The benefits of this approach included: not missing any of the students' actions whilst making notes;

lessening the anxiety of students by making them aware of all the information that was being recorded and, most importantly, allowing the students to respond to, and where necessary illuminate, the observation made.

Questionnaires, interviews and observation were central to the research programme that comprised four studies. The previous chapter reported on the first study, Study I, that examined a traditional conceptualisation of learning strategies. The notion of 'traditional learning strategies' refers to models of learning behaviour that do not account for computer-based learning. In Study I, the traditional measure that was examined was the Motivated Strategies Learning Questionnaire and its underlying conceptual framework (Pintrich, Smith, Garcia and McKeachie, 1989; Pintrich, 1989). The chapter also detailed how the MSLQ was found to be reliable when tested with a sample of students studying Biology, Brain and Behaviour. The remainder of this chapter outlines the remaining studies and the overall methodology of the research programme.

4.3. The research programme

The four studies are collectively referred to as a programme of research because an understanding of the behaviour investigated did not fully emerge until all the studies were completed. The programme of research is outlined in Figure 4.1.

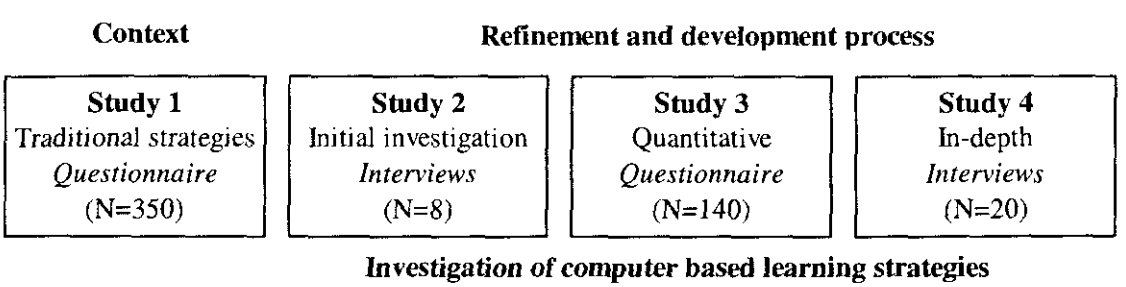


Figure 4.1: Empirical research programme of thesis

4.3.1. Study I

The aim of this study was to investigate the reliability of the MSLQ when tested on a sample of UK distance learners. The purpose of this investigation was to establish the degree to which the framework associated with the MSLQ would be useful in analysing the data intended to be collected about students' computer-based learning strategies. A sample of approximately half the students on the course Biology, Brain and Behaviour were posted the first of two questionnaires half way through the course. Questionnaire 1, included the MSLQ and was intended to examine the internal reliability of the MSLQ. Students who returned this questionnaire and indicated they would like to continue as participants in the research were sent Questionnaire 2. This questionnaire also included the MSLQ, the intention being to compare the responses of the two posting to determine the external reliability of the questionnaire. Part of the questionnaire was aimed solely at users of the CD-ROM and examined briefly their use of this technology. The MSLQ was found to have both internal and test-retest or external reliability when tested with a sample of approximately 300 students studying Biology, Brain and Behaviour. This meant that the conceptual framework of strategic behaviour underlying the MSLQ could be used to frame an examination of students' computer-based learning behaviour.

4.3.2. Study II

Study II comprised eight semi-structured interviews that sought to explore the study practices and behaviour of students in their use of the CD-ROM. The interviews took place after the course had finished. The interviewees were chosen on the basis that they returned both questionnaires in Study I and indicated they were using the CD-ROM. Three of the students were interviewed in their homes face-to-face with the interviewer whilst the remaining students were interviewed by telephone. At this stage in the

research programme, students were not observed using the CD-ROM, rather the emphasis of the interview was on their recall of the experience of using the technology. The interview asked questions about the general study of the course along with when and how the CD-ROM was generally used, its features and tools. The length of interviews ranged from twenty minutes to an hour.

4.3.3. Study III

Based on the findings from Study II about the study practices of students using the CD-ROM, a questionnaire was developed and posted to a new intake of students onto the course in 1999. This questionnaire was termed the SPOTLITE questionnaire and was sent to a sample consisting of approximately half the total number of students enrolled on the course for that year. The questionnaire dealt exclusively with use of the CD-ROM and included three main types of question related to using the CD-ROM. These included what motivated students to use the CD-ROM, how they used the CD-ROM to increase or add to their knowledge and how they managed using the CD-ROM in the time available. The questions on the survey were styled in the same manner as the MSLQ, that is a statement which students responded to on a Likert scale. The responses to these questions were analysed for internal reliability. The main analysis comprised Item Analysis and Factor Analysis to determine particular groupings of questions that would suggest strategic behaviour and add to the findings of Study II.

4.3.4. Study IV

The purpose of this final study was to build upon and further enhance the understanding of computer-based strategic behaviour provided by Study II and III. To this end twenty students on the course who had returned completed questionnaires in Study III were interviewed about their use of the CD-ROM. Fifteen of these students were interviewed face-to-face and five were interviewed by telephone. The interviews with students took

place shortly after the course had ended and on average lasted approximately an hour. These interviews differed from those in Study II in that students were also asked to use the CD-ROM during the interview to support or explore issues raised in their account of using the technology. Again the interviews were semi-structured in style and used a similar structure to that used in the earlier study.

4.3.5. Sampling

The selection of a representative sample is important to the survey approach because the approach aims to provide findings from a sample that is representative of the population being investigated. Therefore, prior to any sampling strategy it is essential to define the target population from which a sample will be drawn (Oppenheim, 1992). In the research programme two populations were to be investigated. The first population, in Study I, was students studying the course Biology, Brain and Behaviour. However, in Study II, III and IV the target population consisted of those students using the CD-ROM. The other defining characteristic of both these populations is that they were distance learners in the Great Britain studying with the Open University.

Although the populations were drawn from the same course, the research involved two separate enrolments of students on to the course. Like Biology, Brain and Behaviour most undergraduate Open University courses run from February to October in any given year. The students who contributed to Study I and II were drawn from the 1998 intake of the course, whilst Study III and IV were drawn from the 1999 intake. In that time the delivery of the course remained unchanged and it was assumed that the two groups could be considered as similar populations in terms of CD-ROM use.

There are two major methods of sampling in designing a survey – probability sampling and non-probability sampling (Cohen and Manion, 1994). In probability sampling each member of the target population has an equal probability of being selected to be

included in the survey. In non-probability sampling, the selection of a sample is biased by some common characteristic. The scope and limits of the research often dictate the use of a particular sampling approach and in the case of the research programme both were utilised.

Students at the Open University are spread over thirteen regions (see Figure 4.2). This allocation of students contributed to the sampling strategies used in the research programme. In Study I the target population consisted of all students studying the course studying Biology, Brain and Behaviour, the sample consisted of all the students studying the course in regions 1, 2, 3, 4, 5, 6 & 13 in the UK. These regions were chosen because Study II would draw on this sample to select particular students to interview about their use of the CD-ROM. It was envisaged that these interviews would take place at the homes of students, therefore it was more convenient if the students were situated within a day's travel of the researcher's base in Milton Keynes. In Study III, use of a questionnaire meant that students were sampled from all thirteen regions. In Study IV, however, where again a number of students were interviewed, the sample was drawn from the seven southern regions identified previously.

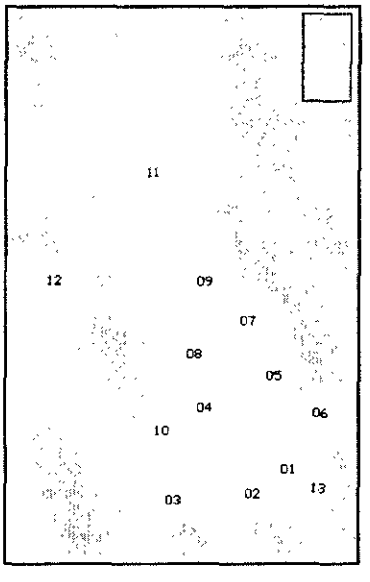


Figure 4.2: Map of Open University regions

In the survey approach it is important that the sample should be as representative as possible to the population under investigation. It is an unavoidable fact that there will be some degree of sampling error, some level of compromise to the accuracy of the sample in representing the target population. The common method that is suggested for overcoming this problem is to have a large sample. In terms of questionnaire studies a large sample decreases the chance of error and it can also increase the number of completed forms that are returned which in a postal survey averages at 65% of the total amount posted (Anderson, 1990).

Study I was designed to investigate the population of students studying the course Biology, Brain and Behaviour and led to the posting of two questionnaires (Questionnaire 1 and 2) to students. On average, the course enrols more than 800 students each year (1998, N=900; 1999, N=861). Anderson proposes that with a population of 1000 a tolerable 5% level of sampling error requires 277 completed and returned questionnaires. This figure, in conjunction with an expected return rate of 65% meant that in Study I the first of the two questionnaires used in this study needed to be posted to just over half the students on the course ((277/65) x 100 = 426.2). Therefore, the questionnaire was posted to the seven southern OU regions to a total sample of 471 students. Three hundred and six students returned the completed questionnaire. From this set of students, 257 agreed to be sent the second questionnaire. Ninety-six of those students returned the completed second questionnaire.

In Study III, the target population comprised those students on the course using the CD-ROM. The CD-ROM was posted to all students and it was an optional part of the course material so this made it difficult to form an accurate picture of its use. Of those students who completed and returned the first questionnaire in Study I, approximately 60% indicated that they had used or were using the CD-ROM. However, with no way of

knowing which students were using the CD-ROM, the questionnaire in Study III was sent to a sample of 500 students spread over the regions.

In the interview studies, Study II and Study IV, the sample sizes were markedly smaller than those used in the questionnaire studies, reflecting how sample size is also a property of design. In terms of interviewing, Hammersley (1993) proposes that sampling continues until the reports do not extend the emerging theory or findings. In Study II, eight students were interviewed about their use of the CD-ROM. There were similar reports of behaviour made by a number of students and it was believed that eight students provided an adequate exploration of how the CD-ROM was used. In Study IV, twenty students were interviewed with the view that a large number of reports could refine and enhance the findings in the earlier studies. This final study also provided an opportunity to observe students using the CD-ROM as a means of confirming their reports of how they used the technology. It also has to be considered that the students were interviewed after the course had finished. Therefore a viable period of recall about using the CD-ROM was considered to be approximately two months after the course finished.

4.3.6. The Course and the CD-ROM

The course from which participants in all the studies were selected is a second level 60 credit course run at the Open University - SD206: Biology: brain and behaviour. The course aims to teach students neurobiological structure and functioning and was chosen as students have the option of using a computer-based resource learning tool - The "Human Brain" CD-ROM.

The CD-ROM has been developed in-house at the OU by the Biology Multimedia Group. Its main purpose is to consolidate the teaching of neurobiological functioning and structure in a medium that is able to present detailed information in a format that is

both easy to use and understand. The topics the CD-ROM covers include: general aspects of the central nervous system, the cerebral cortex, the spinal cord, vision, hearing and speech (see Figure 4.3).

Figure 4.3: Contents of the Human Brain CD-ROM

The CD-ROM incorporates various features including narration, text, static and animated graphics. Figure 4.4 below shows a screenshot taken from the CD-ROM where text has been accessed by clicking on the text button (obscured by the text box). Text hotspots often appeared in these boxes highlighted in blue. When a hotspot is clicked upon with the mouse a second text window appears giving students more information about the highlighted term.

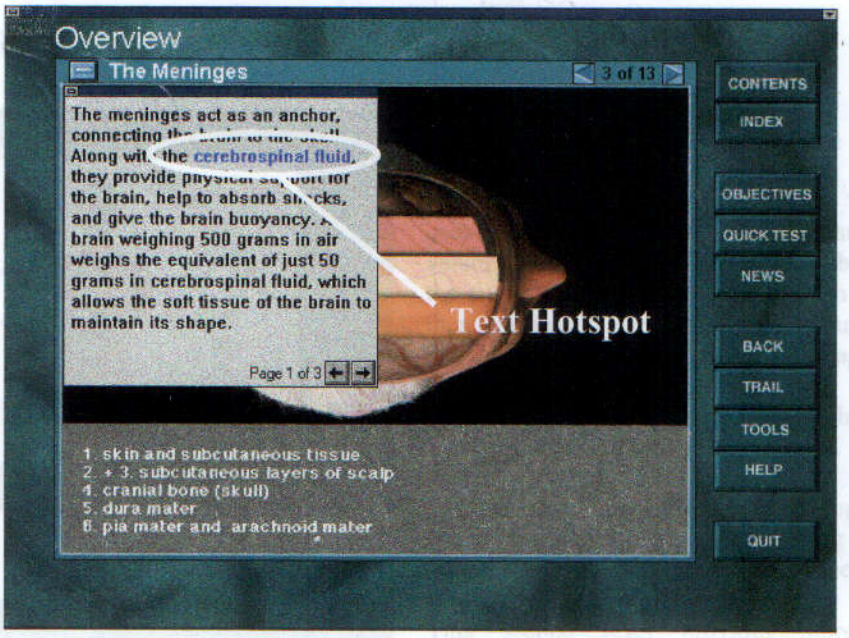
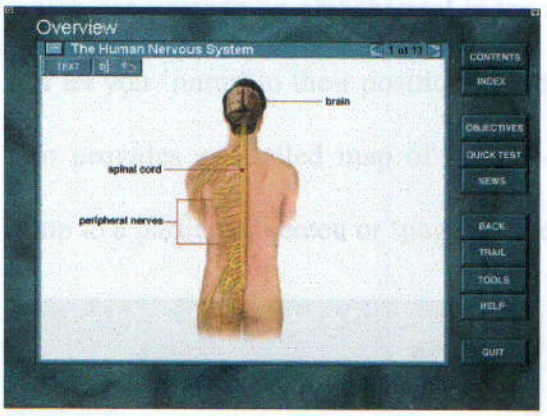


Figure 4.4: Text, text hotspots and graphics on the CD-ROM.

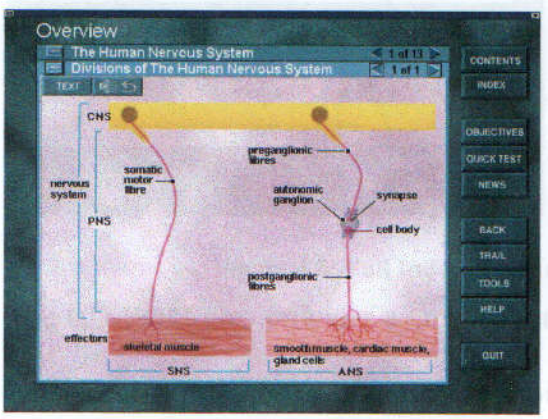
The information in the sections of the CD-ROM is organised in terms of layers. A maximum of three layers of information can be accessed from any screen. The first layer comprises the information the user encounters when they arrive at a 'page' of the section. In this layer, the information on the 'page' is presented in its simplest form. By using the mouse to explore the page they can access the other levels of information, if available, which increase in complexity as more levels are explored (see Figure 4.5).



Level 1

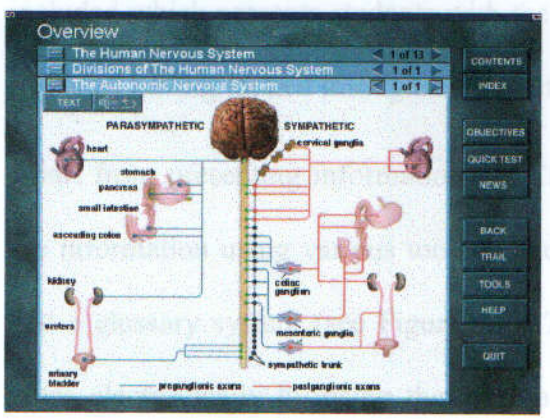
Opposite is the first 'page' of the Overview section on the CD-ROM. By moving the mouse over the diagram the cursor changes to either a *question mark* or an *arrow*. A 'question mark' cursor indicates that if the element above which the cursor appears is clicked upon with the mouse then a definition or explanation of its function will appear in a text box. Much the same happens with the 'arrow' cursor except rather than text appearing the user is transported to a higher level of information concerning the element.

In this case an arrow appears in the region of the spinal cord and the brain. On clicking the mouse button a second level of information then appears.



Level 2

This second level provides more detailed information about the nature of the Human Nervous system. In the screen opposite you can also see that the original 'page' from which the user came to this point is still present in the back ground. Again by moving the cursor over the diagram a change occurs over the 'ANS' section of the diagram and the user can enter a more detailed level of information about the Autonomic Nervous system



Level 3

The third level presents very detailed information about a specific topic or area, in this case, the ANS. Movement across through the levels is also characterised by more information on screen and more detailed and complex images.

Figure 4.5: Layering of information on the CD-ROM

Another way of accessing the various levels of information is by using the Index facility which can provide an alphabetical index of the items that appear on the CD-ROM and can let you 'jump' to their position in the CD-ROM (see Figure 4.6 below). The Index also provides a detailed map of the CD-ROM architecture where again the user can jump to a particular screen or 'page' of the CD-ROM.

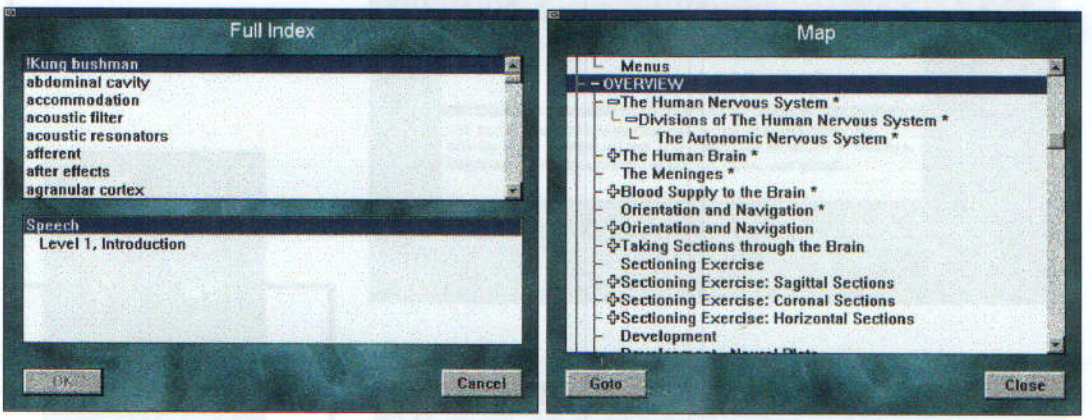


Figure 4.6: Full Index and Map available from the Index facilty

The CD-ROM also provides a Quick Test facility that allows the student to assess their knowledge via a series of multiple choice questions. An Objectives section is also included which presents students with the learning objectives they are expected to have achieved having looked through a complete section.

Apart from presenting information the CD-ROM also allows students to interact with the information using various tools including a notebook, a camera and album facility and a glossary system (see Figure 4.7). The notebook facility allows students to take notes electronically by using the Notepad word-processing facility installed with the Windows operating system. The camera and album facility are used in conjunction with one another since the camera allows a screenshot to be taken of whatever appears on the CD-ROM screen. This image is then placed in one of four available slots in the Album facility. The student can then paste it to other documents or annotate the 'photograph'. The glossary can either present all the items beginning with a particular letter of the

alphabet or the user can type the first few letters of the item they want to find a definition of.

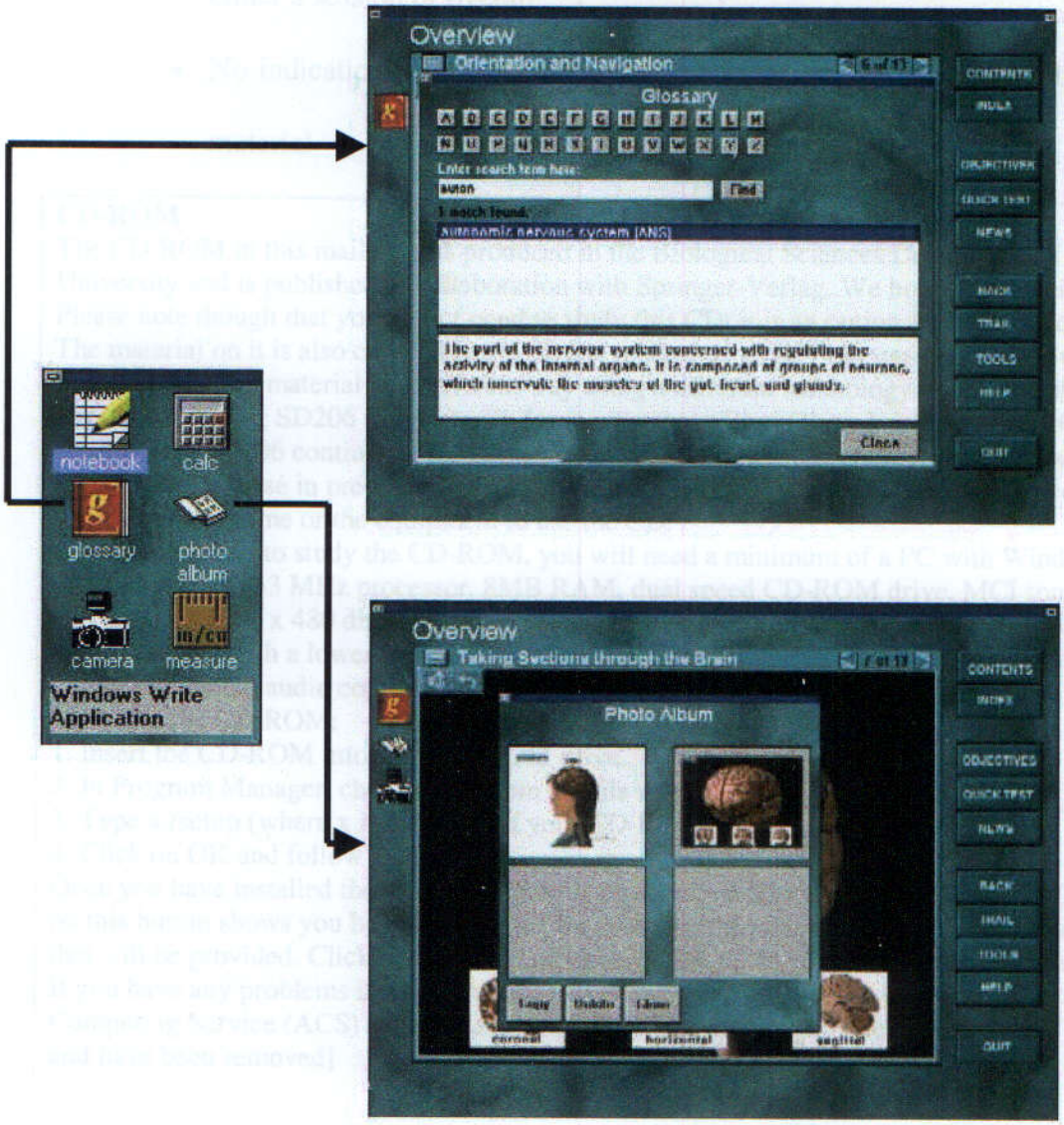


Figure 4.7: The tools on the CD-ROM

The CD-ROM is anticipated to provide approximately 30 hours of study time and is posted to all students approximately halfway through the course to coincide with forthcoming sections of the course. However, the use of the CD-ROM is optional as outlined in the instructions posted to students shown in Figure 4.8 and to be noted from these instructions is that there is:

- No educational advantage specified in terms of using the CD-ROM
- No indication of how much time should be spent studying the CD-ROM in either a session or overall
- No indication of how to study the CD-ROM in relation to the other course material

CD-ROM
The CD-ROM in this mailing was produced in the Biological Sciences Department of the Open University and is published in collaboration with Springer-Verlag. We hope you find it helpful. Please note though that you do not **need** to study this CD; it is an optional part of the course. The material on it is also covered in the SD206 printed texts, in Videocassette 3 etc, but the CD-ROM teaches the material in a different way using a different technology. However, students have been passing SD206 satisfactorily for many years without there being any CD-ROM around. The SD206 continuous assessment and final examination for [year of study] will be comparable to these in previous years, so there is no need for you to feel disadvantaged if you do not have the time or the equipment to use the CD.
If you would like to study the CD-ROM, you will need a minimum of a PC with Windows 3.1 or later, 486DX, 33 MHz processor, 8MB RAM, dual speed CD-ROM drive, MCI sound card and speakers, 640 x 480 display, and 32 thousand colours. You may be able to play the CD-ROM on a PC with a lower specification than this, though the quality of the graphics and your ability to play the audio components of the tutorial may be affected.
To install the CD-ROM:
1. Insert the CD-ROM into your CD-ROM drive.
2. In Program Manager, choose Run from the file menu.
3. Type x:/setup (where x is the letter of your CD-ROM drive).
4. Click on OK and follow instructions.
Once you have installed the CD-ROM there is a section on 'How to use the System'. Clicking on this button shows you how to find your way through the material and use the various tools that will be provided. Clicking on the 'Overview' button takes you straight into the tutorial.
If you have any problems installing the CD-ROM, you can contact the University's Academic Computing Service (ACS) [the remainder of these instructions provide contact details for ACS and have been removed]

Figure 4.8.: Instructions for using the Human Brain CD-ROM

4.3.7. Computer-based study practices questionnaire - SPOTLITE

In Study III a questionnaire was designed to further examine the computer-based learning strategies of students (see Appendix E). The questionnaire was given the name SPOTLITE (Study Practices Of The Learner in Information Technology Environments), in view of the initial framework of strategies that emerged in Study II. It

was decided to use this survey method to gain a larger scale, wider examination of students' behaviour with the CD-ROM than could be accomplished with interviewing.

The SPOTLITE questionnaire comprised four sections. The first section was intended to measure the *Motivational strategies* that accounted for why the Human Brain CD-ROM was used and comprised seventeen items. The second section was intended to measure the *Cognitive strategies* adopted in using the CD-ROM, i.e. how students dealt with the information on the CD-ROM and comprised twenty-two items. The third section was intended to measure *Tool Management* strategies adopted in using the Human Brain CD-ROM and comprised thirty-three items. A final section was included which sought to determine general information linked to using the CD-ROM, including the time spent on the CD-ROM and the sections used.

The SPOTLITE framework that resulted from Study II consisted of twelve strategies which could be separated into three classes of behaviour: motivation, cognitive and tool management. In the construction of the strategy sections of the questionnaire, students' responses in Study II were examined with a view to identifying common behavioural indicators - what could be considered strategies or themes. In the construction of the SPOTLITE questionnaire these categories of responses were examined for common phrases or utterances which were then adapted to a question format.

This process resulted in a pool of 80 items drawn from the three classes of different strategies. This provisional list of items was shown to three independent researchers in the field of computer-based learning who were asked to comment on the selection and phrasing of the questions. This panel was told that the questions were intended to measure the behaviours and processes of students learning from computers but remained unaware of the details of the framework to emerge in Study II and which

questions related to which class or type of strategy. The feedback from the three researchers resulted in a final pool of 72 items.

The phrasing of questions on the SPOTLITE questionnaire was also influenced by the Motivated Strategies for Learning Questionnaire (MSLQ) used in Study I. The revised MSLQ used in that study phrased questions in the first person. It also focused attention to the study of the course by including the course code in every question. This style of phrasing was also used in the construction of the SPOTLITE question with every question including the term CD-ROM to provide the students with a definite context to which they were asked to respond.

The findings from Study I and the use of the MSLQ also framed the response scheme of the new questionnaire – a four point Likert scale. The MSLQ adopts a 7-point scale with only the extreme measures marked (i.e. 1=not at all true of me, and 7=very true of me) and is designed to be used with all items. The SPOTLITE scale was also designed to be used with all items but the points in the scale were marked as follows: 1=not all true of me; 2=not very true of me; 3=fairly true of me; and 4=very true of me.

This response scheme adopts no midpoint and indicates what each point refers to because of findings in Study I concerning the significance that respondents attributed to points on the blank MSLQ scale. After they had completed the questions on the modified version of the MSLQ used, students were asked to indicate what the points between '2' and '6' had represented as they completed the MSLQ. The responses of students were quite varied with the exception of the midpoint of '4' where many reported this indicated 'no opinion'. It is difficult, though, to determine what a 'no-opinion' decision for an item actually signified. That is, the items on the MSLQ have been designed in such a way that they were either irrelevant/untrue or relevant/true to the learning experience. If an item were irrelevant to the students' learning experience

then circling '1' on the response scheme would indicate this. If that was not the case then the item was a feature of the experience and its relevance should have been gauged appropriately on the remainder of the scale. Therefore, it was believed that placing limited parameters on the response scheme of the SPOTLITE questionnaire would lessen the ambiguity of a wider, less specific scale. Also, constructing the response scheme to have an even number of points would make it suitable for the correlation analysis that lies at the core of Item Analysis and Factor Analysis. That is, a midpoint on a scale representing 'no opinion' actually presents two scales, both extending from the midpoint to the outer extreme.

In the Tool Management section of the questionnaire some reversed questions were included: q43, q45, q46, q51, q52, q54, q60, q62 and q69. That is, the responses to these questions needed to be transposed before the items could be included in the analysis. Therefore, a response of 1 on the questionnaire was recoded as 4 and a response of 2 was recoded as 3 etc.

Apart from the sections of the questionnaire that focused on learning strategies, a series of general questions were also included in the questionnaire to frame the potential learning strategy findings. These would examine beliefs about the CD-ROM compared to other course material; time spent using the CD-ROM and beliefs about the features of the CD-ROM. This final section also gave students the opportunity to provide contact details if they were willing to be interviewed about using the CD-ROM. A section was also included for students to add any further comments or indicate their reasons for not using the CD-ROM.

As in the case of the MSLQ questionnaires, the SPOTLITE questionnaire was posted to students along with an accompanying letter that explained the purpose of the survey was to examine their CD-ROM related behaviour if they were using the CD-ROM. If

students were not using the CD-ROM they were asked to state why in the final section of the questionnaire. A pre-printed attachable return address label was included with the questionnaire. Two weeks after the initial posting a reminder postcard was sent to those students who had not returned the completed copy. Two weeks after that another copy of the questionnaire was sent again to students, along with the return address label and letter encouraging them to complete and return the questionnaire.

4.3.8. Interviewing students about their computer-based study practices

The interview was used as a research tool in Study II and IV to investigate the nature of students' learning strategies. Cohen and Manion (1994) identify three main purposes of using interviews in the survey process. The reasons include: addressing the research objectives associated with a project, exploring the issue or social phenomena in question or as a follow up or validating procedure for other research methods.

In both studies the interview was chosen because it would provide information about students' behaviour that would help address the objectives of the overall research programme. However, in Study II the interview served to provide an initial insight into the experience of students using the CD-ROM, whilst in Study IV the interview allowed the findings from the questionnaire and the second study to be further investigated and refined.

Cohen and Manion (1994) identify various types of interview of which the most common is the structured interview, where the sequence and nature of questions is determined beforehand with little or no opportunity for deviation from this scheme. Another common style is the unstructured interview where there is no predetermined structure to the questions or their sequence. In both Study II and IV the style of interviewing could be defined as semi-structured. With this approach a sequence of

questions was followed throughout, but if an interesting point or issue was raised in the discussion then this was also pursued.

In both studies a similar schedule of questioning was used, although as described further on in this section, one of the studies asked students to use the CD-ROM during the interview. The schedule was designed to provide an account of each student's experience of using the CD-ROM and to a lesser extent their experience of studying the course and their general computing behaviour. The questions, however, did not ask students specifically for details of their learning strategies. Rather, it was intended that these processes and behaviours would be determined in the analysis of the accounts provided by students about their use of the CD-ROM. This mirrored the use of interviews to explore students' strategies that was used by Zimmerman (1986, 1989; Zimmerman and Pons, 1986). In both studies the interview comprised five main parts, each of these examined particular aspects of the students' learning experience with the CD-ROM (see Table 4.1.).

Table 4.1: Interview schedule showing parts, aspects and strategy indicators.

Parts	Aspects
General experience of the course	• What they thought about the course. • Previous experience of studying OU courses • Nature of degree • Use of course material
General computing experience	• Computing experience • General Usage
General experience of using the CD-ROM	• Time spent using the CD-ROM • Use of Instruction Section * • Sections used and favourite section(s)* • When the CD-ROM was used in comparison to the other course material • How the CD-ROM was used with the other course material • Navigating around the CD-ROM*
Features of the CD-ROM	• Graphics* • Text* • Narration* • Quick Test* • Objectives* • Organisation of information*
Tools on the CD-ROM	• Glossary* • Camera/Album* • Notepad*
Other aspects of CD-ROM use	• Note-taking • Printing • Problems encountered*

The first part of the interview was concerned with the general study of the course and was intended to refresh the student's memories of their experience studying the course, and subsequently, the context in which the use of the CD-ROM occurred. It was also intended that this initial set of questioning would make the student comfortable with the interview format and procedure. The questioning about the study of the course concentrated on how difficult the individual found the course and how the course related to their previous undertaking of OU courses.

The second part of the interview examined the student's general use of the CD-ROM. This was introduced by examining their general level of computer expertise and experience prior to using the CD-ROM. The students were then asked about their reasons for using the CD-ROM in light of the fact that it was an optional piece of course

material. They were asked to estimate the time they spent using the CD-ROM either in a single session or overall. This part of the interview also determined which sections of the CD-ROM the students had used, along with when and how they had used them.

In the third part of the interview the students were asked various questions concerning the features of the CD-ROM. A feature was determined as a common aspect of each of the various sections on the CD-ROM, that is, animation, text, narration, 3-layer structuring of information, Quick Test facility and the Objectives.

The fourth part of the interview investigated the use of various tools included on the CD-ROM: the glossary, camera/album and Notepad facility. The final part of the interview examined activities such as note-taking, printing and whether any problems occurred in using the CD-ROM. This part also gave students an opportunity to make any comments about the CD-ROM or about using the tool which they felt had not been covered in the interview.

In Study II the interviews were arranged on the basis of those students who completed both Questionnaire 1 and 2 in Study I and indicated they were willing to be interviewed about their use of the CD-ROM. If they agreed in principle to be interviewed they were asked to supply contact details included a telephone number, they were then contacted and an interview arranged. In Study IV, the interviews were arranged in the same manner, again on the basis of students who indicated in the questionnaire used in Study III that they were willing to be interviewed about their use of the CD-ROM. In both studies students were interviewed after the course had finished to gain a more accurate picture of how the CD-ROM was used throughout the course.

In Study II the interviews with students did not make use of the CD-ROM. This was because this initial set of interviews sought to explore and offer an initial insight into the

experience of using the CD-ROM. Thus, it was intended that the findings from Study II would also identify aspects of using the CD-ROM that could be explored by having the students actually use the CD-ROM in later work.

In Study IV, with the exception of the fourth student interviewed (S4), all students were interviewed with the CD-ROM being used at some point during the interview. Table 3.1, (*) indicates what aspects of the interview involved the use of the CD-ROM. In using the computer, students were directed to a particular point of the CD-ROM and asked to perform or talk through an activity depending on the aspect of the interview being covered. In most cases use of the CD-ROM during the interview took place on the students' own computer. In some cases where the students were interviewed face-to-face, a colour PC laptop, with the CD-ROM installed, was used (S1, S2, S7, S10, S11 and S12). Any activity performed with the computer during the interview was not itself regarded as a measure or indicator of strategic behaviour. The CD-ROM was used to facilitate recall and support their accounts of the learning experience with the CD-ROM.

Initially, it was envisaged that in both studies the interviewing would occur face-to-face with students in their own homes, so as to provide an environment familiar to them in terms of their study practices. However, with contact and commitment to interviewing proving difficult as the process of interviewing continued, and travel to the homes of students requiring a substantial amount of time, a number of interviews were carried out by telephone.

In Study II three of the students were interviewed face-to-face in their homes by the interviewer and the remainder were interviewed over the phone. In Study IV fifteen of the students were interviewed face-to-face in their homes and five over the telephone. In this study it was arranged beforehand with those students who were interviewed over the telephone that when the interview took place they would be interviewed using the

telephone and sitting in front of their own computer. These students were asked to report or confirm any activity they performed on the CD-ROM when they used it. On the other end of the telephone the interviewer sat with a computer, mirroring the student's actions.

In the case of both interviews carried out face-to-face and over the telephone, consent was sought for the interviews to be recorded on audiocassette and in all cases this was granted. Considering the exploratory nature of the interviews, all dialogue between interviewer and participants was recorded onto audiocassette. Oppenheim (1992) supports the recording of interviews on the basis that much of the information will escape the interviewer during the actual interview process. Also, a permanent record of the dialogue that occurred serves not only to aid the recall of detail and subsequent analysis made by the interviewer, but also allows other parties to examine the dialogue.

4.3.9. Timing and Behavioural Opportunity

One of the important factors that had to be considered in planning the programme of research was the timing of the four investigations in line with the start and the end of the course, various assessments and most importantly the use of the CD-ROM. The Biology, Brain and Behaviour course begins in February and ends in October. To establish the learning strategies of students at a time far enough into the course when routine in study behaviour had been established, most of the testing took place half way through the course or after the final exam assessment. This limited the amount of time allowed for each investigation and meant that the four studies were carried out over a period of two years with two separate intakes of students on to the course.

In Study I it was important to establish the learning strategies of students at a time when a routine in study behaviour had been established but also allowing enough time for two questionnaires to be sent to students. To this end the students were sent Questionnaire 1

half way through the course in June of 1998 and Questionnaire 2 in August. The interviews comprised Study II took place between November and December of the same year.

In Study III again a questionnaire was sent to students, this time to the 1999 intake for the course. The questionnaire was intended primarily for users of the CD-ROM. It was sent to students in July after consultation with the course team about the point in the course where it was predicted that most students would have used the CD-ROM for an extended period of time. Again, in Study IV, the questionnaire was followed by a series of interviews with students starting in October and running up to the Christmas period of 1999.

4.4. Analysis of questionnaire data

This section details how the questionnaire data collected from Study I and III was analysed. The MSLQ data collected from Study I was mainly analysed to test the reliability of the questionnaire. In Study III the development of a novel questionnaire to measure computer and CD-ROM related behaviour led to Factor Analysis and Item Analysis being used to identify sets of responses that could be interpreted as evidence of strategic behaviour. The rationale for these analyses is also reported in this section.

4.4.1. Reliability

One of the purposes of Study I was to show that a modified version of the MSLQ retained its reliability when tested with a sample of UK students studying at a distance. By showing that the MSLQ was reliable, the remainder of the research programme could use its underlying conceptual framework to frame the examination of students' computer-based behaviour.

Generally, two aspects of reliability can be examined statistically: internal and external. In the case of the MSLQ, the former refers to the degree to which the different items

that comprise each of the subscales are scored consistently. External reliability is often referred to as test-retest reliability. It is established by correlating the responses of a group of subjects to the same measure on two testing occasions.

Cronbach's alpha was used to check the internal reliability of each of the subscales; that is, the degree to which the different items that comprised each of the subscales were scored with consistency. Cronbach's analysis is most commonly used as an indicator of internal reliability in psychometric measures where items are measured along a scale. A figure of 0.7 is generally accepted as a good indicator of reliability (Kline, 1993). The reliability of the factors that emerged from the questionnaire in Study III was also checked using Cronbach's alpha.

4.4.2. Factor Analysis

Essentially, Factor Analysis can be thought of a method that reveals the relationships that exist between sets of items in a test. The basis of the analysis is the notion of factors, hypothetical constructs that provide an account of the correlations between a set of variables. The technique was used in Study III to reveal if strategic behaviours emerged from the questionnaire and if these could expand on the findings of Study II. In analysing the questionnaire data from Study III, three separate Factor Analyses were performed, one for each set of items believed to measure Motivation, Cognitive and Tool Management strategies.

There are essentially two ways in which Factor Analysis can be used, as an exploratory technique, to examine a previously untested set of variables for their underlying factors, or to confirm the existence of factors that have been derived in previous testing occasions. This section deals solely with Factor Analysis as an exploratory technique as this reflects its use in Study III.

Essentially there are five stages involved in carrying out any exploratory Factor Analysis. Firstly, all items in the set being analysed are correlated with one another. Secondly, a particular method is chosen to determine the factors that account for the relationships between items. Thirdly, a decision has to be made about the number of viable factors to consider and their nature, either related or unrelated. Then this specified number of items is 'rotated' to determine which items relate to what factors. Finally, on the basis of which items load on to particular factors, the factors can be named.

A number of different Factor Analytic methods exist and in the case of Study III, it was decided that Principal Components would be the most appropriate analysis. The main advantage over other techniques is that it assumes that each item included in the analysis has the initial potential to load on to a particular factor. In part, confidence in adopting this method was based on the fact that the items in the SPOTLITE questionnaire were adapted from statements related to the use of learning strategies in Study II. Thus, there was an initial belief in all the questions' ability to elicit responses that could be used to measure the strategic behaviour.

Having carried out the Principal Components it was then necessary to decide the number of factors to extract. Two commonly used criteria were applied, firstly pre-rotation factors had to have Eigenvalues greater than 1 and then a Scree test, essentially a graph of the Eigenvalues, was also produced. The Eigenvalue is essentially a reflection of the variance explained by the unrotated factor. In a set of unrotated factors these values decrease as the number of factors increase. However, this method can lead to the number of rotated factors being overestimated. To that end the Scree test was also used to determine the number of factors to rotate.

In this technique developed by Cattell (1978), a graph is constructed of the unrotated factors and their corresponding Eigenvalues. The number of factors to be rotated can be determined by where the line of the graph changes slope. This adjustment in the line's direction is quite evident because the Eigenvalues of the first few unrotated factors produce a distinct gradient to the plateau shape of the line produced by latter unrotated factors. In Figure 4.10 below, taken from the Scree test of a selection of items used in Study III the X axis of the graph represents factors/components. The line mapping these factors against their Eigenvalue changes gradient at the fifth factor but, because this factor has an Eigenvalue less than one, four factors are considered worthy of rotation.

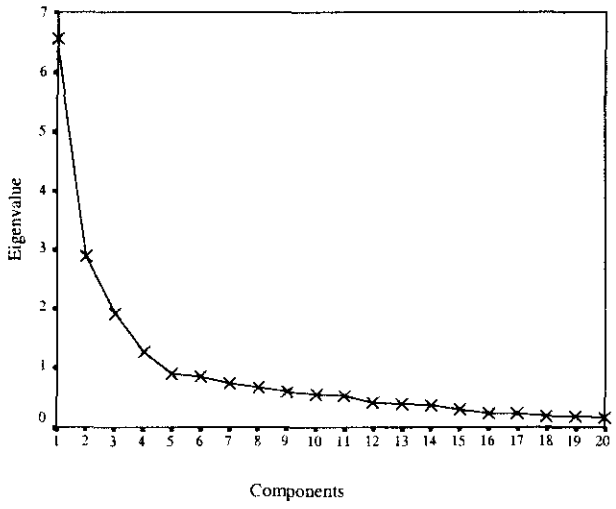


Figure 4.9: Scree Plot of potential factors Cognitive Items used in Study III

Having determined the number of factors, their nature also needed to be considered. Two types of factors can be extracted. Factors can be orthogonal or oblique, i.e. unrelated or related factors. It was decided to extract oblique factors rather than orthogonal factors for each of the factor analysis carried out in Study III. This was because it was assumed that, consistent with the findings from Study I, that there would be a greater likelihood of strategies/factors in the same class correlating with one

another. Therefore having decided to extract oblique factors, the most suitable method of rotation is Direct Oblimin.

Rotation produces a series of correlation between questions and factors, referred to as factor loadings. By examining the table of factor loadings produced for each set of items, it was possible to determine the nature of the factors, or strategies, that arose from each set of items.

A factor loading is produced for each item and each factor, thus for each item in the three Factor Analyses reported in here, there would have been four factor loadings. The highest figure determined which factor an item loaded onto. However, a significant factor loading was needed for an item to be considered successful in loading on to a particular factor. Based on the size of the sample, a factor loading of 0.5/-0.5 or above was considered to be significant (Hair, Anderson, Tatham et al., 1984). The factor loadings appear as both negative and positive figures, but these have no bearing on the nature of the factors themselves, the interpretation of a factor being significant is all that can be achieved from these figures.

Examining the questions that loaded on to a particular factor comprised the final process of identifying the factors as strategies. These factors are discussed in detail in Chapter 6 that reports on Study III.

4.4.3. Item Analysis

Item Analysis is used to select questions or items from an untested questionnaire or survey that form a homogenous discriminating scale (Kline, 1986). In Study III Item Analysis was used to determine which items to include in the three Factor Analysis described in the previous section.

The procedure involves the computation of two figures: the correlation of each item with the total score and the proportion of participants who answered each item with the keyed response (Kline, 1998). The keyed response is the reply expected in relation to a question if the respondent identified with, or demonstrated, the behaviour or processes measured by the overall test. Thus, if asked to respond to the statement 'I want to do well on the course' as part of a test examining motivation to study, the answer of 'yes' or a high score on a Likert scale would be the keyed response.

There are essentially two main methods of calculating the correlation of the item with the total score, firstly, Pearson's product-moment correlation, which is advised when questions are responded to on a Likert scale (Nunnally, 1978). However, correlation conducted using a scale that offers a mid point of no opinion should be considered with caution since the scale should offer a single continuum of behaviour rather than two that extend from the midpoint to each extreme. Kline (1986) advocates the use of a second method - point-biserial correlation. This is an adaptation of the correlation method to be used with items with a dichotomous response scheme, e.g. yes/no, true/untrue. The method also allows items that are answered on a larger scale to be reduced to a dichotomous scheme of keyed/non-keyed response. The main advantage of this method is that it makes no assumptions about the distribution of scores being normal, unlike Pearson's correlation. In Study III both types of correlation are presented for each item to allow comparison of the two methods.

At their strictest, the guidelines for Item Analysis dictate that a question is believed to be an acceptable measure of the test, firstly, if the item correlates highly with the total score of the items (Kline (1998), suggests that this correlation should exceed 0.3). Secondly, a keyed response should be reported by 20% to 80% of the sample. This is to maximise the discriminating power of the test because if the keyed response was made

by a lower or higher proportion of the sample then it would essentially be making no discriminations at all.

Generally, Item Analysis is considered an efficient and reliable technique for establishing a homogenous discriminating scale, however, a general criticism can be directed at its dependency on the correlation statistic. There is the potential for a statistical artefact to occur. That is, where a large proportion of the questions in the test did not measure what they were intended to in the first place, they would still correlate with the total score of the items.

Even when the Item Analysis can be considered to identify items that collectively form a homogenous test, there is a chance that the items are not factorially pure. That is, the items could relate to more that one factor. For this reason, Nunnally and Bernstein (1994) argue that Item Analysis should be followed by Factor Analysis to ensure the factorial purity of test. Having detailed the analysis of the questionnaire data used to examine the learning strategies of students, the next section details the nature of the qualitative analysis carried out for the interview data collected in Study II and IV.

4.5. Analysis of interview data

In terms of educational research, Cohen and Manion (1994) advocate a phenomenological approach to the analysis of interview data. They draw on the guidelines for analysing interview data proposed by Hycner (1985). This set of guidelines is not meant as prescriptive and both sets of writers acknowledge that there is no single convention to dealing with this form of data. Rather, the approach to analysing interview dialogue is determined by the research aims and to an extent by the data itself.

The analysis of the interview data collected in both Study I and II involved a recursive process of reducing and interpreting the data collected from individuals and the samples

interviewed. The outcome of this process in both studies was a series of goal driven behaviours and practices that were identifiable as strategies. This method could be described as phenomenological or thematic analysis, but it is more accurate to consider it an analysis of the interview data driven by the research question of "what are the nature of students' computer-based learning strategies".

Hycner proposes a number of discrete stages in analysing interview data and these were applied to the interview data. It is suggested that initially importance is placed on processing and interpreting the data collected from each individual and here the analysis of a dialogue involves three main stages: appreciation of context, determining general meaning and determining themes. The fourth and final stage involves the identification of common themes between the various interviews conducted.

Appreciation of the experience reported by the interviewee is an important part of the process since interpreting the data relies as much on skill as an appreciation of the context described in the discourse and an understanding of the general context of the phenomenon. The decision to study students on the course Biology, Brain and Behaviour was in part made because it presented a context that could be appreciated by the researcher. That is, the course was similar to one studied previously by the researcher as part of his undergraduate degree in Psychology. Also, an extended period of time was spent becoming familiar with the design and various facets of the CD-ROM.

In the second stage Hycner proposes that a level of general meaning is determined from the utterances or dialogue in the interview and that these are sorted into those that are relevant to the research question and those that are not. General meaning is determined by examining an utterance and identifying the intent or referential aspect of that dialogue.

In the third stage meanings are classified into clusters of meaning or themes (Boyatzis, 1998). A theme is described by Boyatzis as a pattern that emerges or is evident in the information being analysed. At a minimum it describes and organises various observations, at its most extreme a theme can offer an interpretation of the phenomenon. For Boyatzis, a particular theme can be based on established theory, prior data or research, or emerge from the raw data being analysed. Themes can also emerge from a combination of all these techniques and this was the manner in which themes were determined from the data collected in the studies reported here.

In the analysis of the interview data in both Study II and IV, the processes of establishing themes was a recursive process as recommended by Savenye and Robinson (1996) and outlined by Aronson (1994). The data was examined and sorted into four categories. The first of these related to data collected in the initial part of the interview about study of the course. The information collected in the other parts of the interview about using the CD-ROM, its features and tools was initially separated into information about why the CD-ROM was used, what knowledge related purposes using the CD-ROM served and how its use was managed in the time available. These categories were based on the motivation, cognitive and resource management classes of strategies that separate the various strategies in the MSLQ framework (Pintrich, 1989; Pintrich, et al, 1989). The data in each of these themes was then further analysed for evidence of specific strategies. Initially, the strategies that were sought were those identified in the MSLQ framework for that particular class of behaviour. The data was then searched for any discrete behaviour that could be identified as evidence of strategic behaviour. This procedure was performed for both Study II and IV.

The final and most important stage recommended by Hycner is a comparison of themes across the group of individuals interviewed. This would establish common themes or in

the case of Study II and IV would identify common strategies. A common strategy was identified on the basis of two criteria. Firstly, all the dialogues in a study were examined for utterances or themes made by two or more students. Secondly, because strategies as constructs typically represent a continuum, behaviour or reports from different students that were conflicting but mentioned in the same context of using the CD-ROM were also considered as evidence of strategic behaviour. Again reports of these opposite behaviours were only considered if made by two or more of the students interviewed.

This process of identifying strategies was probably influenced by findings from the other studies in the programme and the literature that was reviewed. Unfortunately, the analysis of qualitative data is prone to such influences and rather than deny them it is recommended that researchers acknowledge them and are wary to limit their impact as much as possible (Savenye, 1996; Boyatzis, 1998).

4.6. Summary

This chapter provides details of the methods used to investigate the strategic behaviour of students. In total four studies were conducted. Study I examined the traditional learning strategies of students using the MSLQ and the reliability of this questionnaire. In Study II a set of interviews were conducted with students about their use of the CD-ROM and from the findings a framework of computer-based strategies was formulated. This framework was called SPOTLITE – Study Practices Of The Learner in Information Technology Environments. In Study III, this framework fed into the development of a questionnaire that was used as a quantitative measure of computer-based strategic behaviours. In the final study, Study IV, a series of in-depth interviews and observations of students using the CD-ROM were used to present a revised framework of computer-based learning strategies.

These studies, referred to as a programme of research, were also detailed along with the rationale associated with their planning and implementation. The previous chapter reported on the first of these studies, Study I. In the next three chapters, the core of the thesis research is detailed. Each chapter documents the findings from one the three studies that examined students' computer-based learning behaviour beginning with Study II in the next chapter.

Chapter 5

STUDY II: A PRELIMINARY INVESTIGATION OF STUDENTS' LEARNING STRATEGIES USING INTERVIEWING.

5.1. Introduction

This chapter reports on a study that investigated the learning strategies of students learning in a computer-based learning environment. The main aim of this study, Study II, was to determine the nature of students' learning strategies when using the CD-ROM. A lesser aim was to determine how these strategies compared to conceptualisations of learning strategies used in the study of traditional course material.

The study comprised a small-scale set of interviews with eight students on the course SD206, who completed both questionnaires in Study I and also used the Human Brain CD-ROM. The students were interviewed about their use of the CD-ROM and their reports of the experience were analysed using a phenomenological analysis.

In Study I, the MSLQ established the learning strategies of students on the course SD206: Biology, Brain and Behaviour when studying traditional course material. The study also established that the conceptual framework underlying the MSLQ was reliable and could be used as a context against which to compare the computer-based learning strategies of students.

The following sections of this chapter outline the method used to investigate the nature of students' computer-based learning strategies in this initial study as well as the findings from the interviews. The implications of these findings are discussed and a new framework of learning strategies specific to a computer-based learning environment is presented in the final sections of this chapter.

5.2. Method

5.2.1. The Interview Sample and Participants

The second questionnaire that was sent to students in Study I asked users of the CD-ROM if they would agree to be interviewed about their use of the tool. The questionnaire was sent to 250 students and was returned by 96 students. Of these, 45 indicated that they were using the CD-ROM and 26 agreed to be contacted with a view to arranging an interview. In total, eight students were interviewed, two were males and six were females with a mean age of 45.4 years (SD=6.9). Table 5.1 provides details of the students who agreed to be interviewed.

Table 5.1: Details of interviewees

	Gender	Age	Interview Method
Student 1	Male	46	Face-to-face
Student 2	Female	43	Telephone
Student 3	Female	51	Telephone
Student 4	Female	39	Face-to-face
Student 5	Female	59	Telephone
Student 6	Female	43	Telephone
Student 7	Female	37	Telephone
Student 8	Male	45	Face-to-face

5.2.2. The Interview Process

Study II started in mid-October 1998 following the completion of the course and exam assessment. In August, students had been sent a second questionnaire that asked students to provide contact details if they agreed to be contacted with a view to arranging an interview about their use of the CD-ROM.

Originally it was intended that all interviewing would occur face-to-face with students in their own homes, so as to provide an environment familiar to them in terms of their study practices. However, with contact and commitment to interviewing proving difficult, and travel to the homes of students requiring a substantial amount of time, it was decided to interview some students using the telephone. In the experience of the Open University, this practice has proved particularly useful in following up students'

experiences of studying at a distance. Therefore, a number of interviews were carried out via the telephone.

Both face-to-face and over the telephone interviews were recorded with the consent of the interviewees. Students were interviewed individually and the interviews lasted between 20 minutes to an hour.

5.2.3. The Interview Schedule

Both types of interview, face-to-face and telephone, were based on a semi-structured schedule of questioning but did not ask students specifically for details of their computer-based learning strategies. Rather, it was intended that these processes and behaviours would emerge in the analysis of the accounts provided by students about their use of the CD-ROM.

The schedule was designed to be exploratory and, at a very general level, also incorporated notions about motivational, information processing and resource management strategies. The interview covered five areas of questioning and each of these examined particular aspects of the students' learning experience with the CD-ROM (see Table 5.2.). These included the general study of the course and use of the CD-ROM including its features and tools.

Table 5.2: The Interview Schedule

Parts	Aspects
General experience of the course	• What they thought about the course. • Previous experience of studying OU courses • Nature of degree • Use of course material
General computing experience	• Computing experience • General use of computers
General experience of using the CD-ROM	• Time spent using the CD-ROM • Use of Instruction Section • Sections used and most used section(s) • When the CD-ROM was used in comparison to the other course material • How the CD-ROM was used with the other course material
Features of the CD-ROM	• Graphics • Text • Narration • Quick Test • Objectives • Organisation of information
Tools on the CD-ROM	• Glossary • Camera/Album • Notepad
Other aspects of CD-ROM use	• Note-taking • Printing • Problems encountered

The first part of the interview, the general study of the course, was intended to refresh the students' memories of their experience studying the course, and subsequently, the context in which the use of the CD-ROM occurred. It was also intended that this initial set of questioning would make the student comfortable with the interview format and procedure. The actual questioning concerning the study of the course concentrated on how difficult the individual found the course and how it related to their previous study of OU courses.

The second part of the interview, which examined the student's general use of the CD-ROM, was introduced by examining their general level of computer expertise and experience prior to using the CD-ROM. The students were then asked about their reasons for using the CD-ROM in light of the fact that it was an optional piece of course

material. They were asked to estimate the time they spent using the CD-ROM either in a single session or overall. This part of the interview also determined which sections of the CD-ROM the students had used, along with when and how they had used them.

In the third part of the interview the students were asked various questions concerning the features of the CD-ROM. A feature was determined as a common aspect of each of the various sections on the CD-ROM, that is, animation, text, narration, 3-layer structuring of information, Quick Test facility and the Objectives.

The fourth part of the interview investigated the use of various tools included on the CD-ROM: the glossary, camera/album and Notepad facility. The final part of the interview examined activities such as note-taking, printing and whether any problems occurred in using the CD-ROM. This part also gave students an opportunity to make any comments about the CD-ROM or about using the tool which they felt had not been covered in the interview.

5. 3. Use of the CD-ROM: questionnaire findings

This section concentrates on the responses of the eight students to Part B of the second questionnaire used in Study I. This part of the questionnaire was directed specifically at users of the CD-ROM. The questions focused on three main areas of the computing experience: general experience of using computers; general experience of using the CD-ROM and their experience in using the various features incorporated into the tool. This data is presented here to frame the next section of the chapter that presents the findings from the interview data.

5.3.1. General Computer Use

Table 5.3: General Computer Use

Student	Had they used a computer prior to using the CD-ROM	Where did they generally use a computer	How often was the computer used	Was this the first learning experience with a CD-ROM	Time (in hours) spent using CD-ROM (2 months before interview)	Where did they use the CD-ROM
1	Yes	Home & Work	Daily Basis	Yes	2	At home
2	Yes	Home & Work	Varied	Yes	4	At home
3	No	-	Not often at all	Yes	4	At home
4	Yes	At home	Daily Basis	Yes	4	At home
5	Yes	At home	Varied	Yes	14	At home
6	Yes	At home	Daily Basis	Yes	30	At home
7	No	-	Not often at all	Yes	25	Other
8	Yes	At home	Daily Basis	Yes	-	At home

Two of the eight students who were interviewed had never used a computer prior to using the CD-ROM (student 3 and 7) see Table 5.3. Students 4, 5, 6 and 8 reported using a computer at home, whilst student 1 and 2 reported using a computer at both home and work. Four of the eight students used a computer on a daily basis (students 1, 4, 6 and 8) whilst students 3 and 7 reported not using a computer often at all. For all students this was their first experience of using a CD-ROM in their study of OU course material. Students 5, 6 and 7 reported spending the most amount of time using the CD-ROM, with student 6 reporting 30 hours of use, whilst students 1, 2, 3 and 4 all reported

spending less than 5 hours. It should be noted that these reports of the time spent with the CD-ROM were made at the time of completing the postal questionnaire, approximately two months before the students were interviewed. This use may have increased for some of the students by the time they came to be interviewed. With the exception of student 7, all the students used the CD-ROM at home. Student 7 reported in the interview that she had used the CD-ROM at her father's house.

5.3.2. General Use of the CD-ROM

Table 5.4 details the various sections that the students reported using approximately two months before they were interviewed and what role the sections they used played in their studies of the course. The way in which the sections were used may have altered by the time the interviews were conducted but this early set of reports still allows an examination of how the CD-ROM was used. In Part B of the second questionnaire, the students were asked how they had used each section of the CD-ROM in the time since they had received the CD-ROM. The student were asked to choose from the following options: as an introduction to the content of the section, i.e. an initial tutorial; for revision; as a reference source to subject matter in the other course materials; or as a means to learn about the content of the section. It is worth noting that students were given no instructions on precisely how the CD-ROM should be integrated with the study of other course material instead it was highlighted that study of the CD-ROM was optional and not mandatory.

With the exception of students 3 and 4, in about the four months the students had had the CD-ROM they made use of all the sections it included. Primarily, this was as an introduction to the subject matter included in each of the sections. Students 6, 7 and 8 reported quite similar behaviour in that they used all the sections on the CD-ROM for revision and referencing. Interestingly, only students 5 and 6 reported using all the

sections as a means of learning about their subject matter. Student 1 reported using all the sections of the CD-ROM but only as an initial tutorial.

Table 5.4: Use of Sections

Student	Initial tutorial	Revision	Reference	To learn about section
1	• All	-	-	-
2	• All	• Cerebral Cortex • Vision • Hands on the brain	-	• Overview
3	• Overview • Spinal Cord	• Spinal Cord	• Cerebral Cortex	-
4	• Overview	-	-	• Cerebral Cortex • Vision • Hearing • Speech
5	• All	-	• Spinal Cord • Vision • Hearing • Hands on the brain	• All
6	• All	• All	• All	• All
7	-	• All	• All	-
8	• Overview	• All	• All	-

Students were also asked about how the CD-ROM compared to the other course material, that is course texts and video (see Table 5.5). The course texts form the principle source of study material for students on the course but a video is also provided which allows students to see graphic representations of neurophysiological structure and functioning. In comparing the amount of time spent studying the CD-ROM to the other course material, both the texts and the video, the responses of students were quite varied. Students 1 and 8 reported the time spent with the CD-ROM as being *less*; students 3 and 7 as *more;* and students 4 and 6 as the *same*. Generally, most of the students thought the CD-ROM was either *better for some topics* or *better overall* in comparison to the course texts. In terms of the video, only student 3 considered this form of presentation *not as good* as the CD-ROM, students 1 and student 6 considered it

the *same*, students 2, 7 and 8 considered the CD-ROM *better for some topics*, whilst students 4 and 5 considered the CD-ROM *better overall*.

Table 5.5: Comparison of CD-ROM to other learning mediums

Student	Amount of time spent studying the same material with CD-ROM compared to books/video	Studying CD-ROM compared to books	Studying CD-ROM compared to video
1	Less	Better for some topics	Same
2	-	Better overall	Better for some topics
3	More	Better overall	Not as good
4	Same	Better overall	Better overall
5	-	Better for some topics	Better overall
6	Same	Same	Same
7	More	Better overall	Better for some topics
8	Less	Better for some topics	Better for some topics

5.3.3. Features of the CD-ROM

The questionnaire also explored what the students thought about some of the common features of the CD-ROM (see Table 5.6). A feature in this context could be considered an aspect common to all the sections on the CD-ROM, for example the organisation of the information into layers (see Chapter 4, Figure 4.5 page 79) or the common occurrence of graphics.

The students were asked how limiting they found the 3-layered structure. Student 3 found this organisation very limiting and student 7 found it *fairly* limiting. However, the other students reported that it was *not very* limiting with student 1 reporting it as *not at all* limiting. What students found limiting or valuable about the organisation of the information was not explored in further details using the questionnaire but was addressed in the interviews.

In terms of using the Index/Map system to explore the CD-ROM, student 3 was the only student to report using this feature constantly. Students 5, 6 and 7 reported using it to explore the CD-ROM most of the time and students 2, 4 and 8 some of the time.

In terms of the amount of text included on the CD-ROM students 3, 5, 6 and 8 reported that the amount of text was *about right*, whereas student 2 and 4 indicated that it was *too much*. Most of the students (students 2, 5, 6, 7 and 8) thought that the amount of narration on the CD-ROM was *about right* but students 1, 3 and 4 thought that the amount of narration was *too little*. All eight students thought that the amount of graphics on the CD-ROM was *about right*. In terms of the video content on the CD-ROM

students 2, 4 and 8 believed that there was *too little* whilst the remainder of the students reported that the quantity was about right.

Table 5.6: Features of the CD-ROM

Student	How limiting was the 3-layered structure	Was the Index/Map used to explore the CD-ROM	Amount of text	Amount of Narration	Amount of Graphics	Amount of video
1	Not at all	Not very often	Too little	Too little	About right	About right
2	Not very	Sometimes	Too much	About right	About right	Too little
3	Very	Constantly	About right	Too little	About right	About right
4	Not very	Sometimes	Too much	Too little	About right	Too little
5	Not very	Mostly	About right	About right	About right	About right
6	Not very	Mostly	About right	About right	About right	About right
7	Fairly	Mostly	Too little	About right	About right	About right
8	Not very	Sometimes	About right	About right	About right	Too little

5.3.4. Summary of questionnaire findings

In the questionnaire, most of the eight students interviewed indicated that they were experienced computer users prior to using the CD-ROM. The students differed considerably in how much time they spent using the tool, although a general distinction could be made between moderate and extensive use of the CD-ROM. The students also varied in terms of what sections of the CD-ROM they used and what role these sections played in their general study of the course material. Overall, the CD-ROM was considered more favourably than other learning tools in its presentation of information and its features, in terms of text, graphics and narration, were considered satisfactory.

5.4. Use of the CD-ROM: interview findings

This section presents the findings from the interviews in terms of each of the five parts of the interview schedule: the general study of the course; general use of the CD-ROM; the features of the CD-ROM; use of the tools on the CD-ROM and activities whilst using the CD-ROM. These findings are discussed in more detail in the final discussion section of the chapter that also considers the framework of strategies that emerged from the thematic analysis.

5.4.1. General study of the course

All the students had previously studied Open University courses either from the natural sciences, most often Biology, or social sciences, most often Psychology. The number of courses they had studied varied but in the cases of students 4, 6, 7 and 8 Biology, Brain and Behaviour was one of the final courses the students would be studying to complete their degree. In all cases, this was the only course being studied in the academic year running between February and October. The course was described as challenging by all eight students, both in terms of workload and content. Students 6 and 7 commented that the difficulty of the course was eased to a certain degree by their previous study of biology courses. This was supported by students 2, 4, 5, and 8 who had previously studied mainly social science courses to gain recognition of their final degree by the British Psychological Society.

5.4.2. General use of the CD-ROM

The second part of the interview dealt with the general use of the CD-ROM including students' reasons for using the CD-ROM, the time they spent using the CD-ROM and what sections they used in that time.

Reasons for using the CD-ROM

The CD-ROM was an optional part of the course material; no student was obliged to use it, even though all the students on the course were provided with a copy. Three main responses were given when the interviewees were asked why they had used the CD-ROM: the value or novelty associated with computer technology (students 1 and 5); secondly, an expectation that it would be beneficial to the study of the course as reported by students 5, 6 and 7; and finally, some students (students 2, 6, and 7) reported using the CD-ROM because it was available as part of the course material. Student 4 reported travelling for more than three hours to her father's house to use the CD-ROM because, like other students, she believed it was beneficial to the study of the course.

Time spent using the CD-ROM

Rather than give a total estimate of the time spent using the CD-ROM, most students reported that they spent approximately one-to-two hours using the CD-ROM every week. For many students the CD-ROM was studied in isolation from the other course material. In the transcripts it is possible to distinguish between time that was spent on the information content of the CD-ROM and time spent on learning or problem solving the technical aspects of the CD-ROM software and the computing equipment used to run it (students 1, 6 and 7). For many students, the majority of the time spent using the CD-ROM was devoted to the content (see example of dialogue with student 5).

> *Student 5: [time spent using the CD-ROM] was in fits and starts..I didn't you know do a bit a week...once I sat at it I stayed there for some time*
>
> *Interviewer: Were you quite attentive to the amount of time you were spending with the CD-ROM?*
>
> *Student 5: Well not when you are there because you tend to sit for hours without realising time is going so you are hooked it leads you on to another bit and you carry on. So I didn't say I am going to use it for an hour because I could be there for three*

Use of sections

This part of the interview explored whether the students had used all the sections on the CD-ROM. It also examined when the students used the CD-ROM in relation to the other course material, that is, before, during or after (see Table 5.7). Most students reported exploring all sections of the CD-ROM (students 2, 4, 5, and 6). This was not the case for students 3 and 8. However, student 3 claimed that she felt "incapable" of using all the sections, that she lacked the computing expertise to go through all the sections. The student did report that she would have liked to have made all of the sections and, even though the course had finished, intended to return to the CD-ROM to examine it to a greater extent. Student 8 reported that, primarily, issues related to time management prevented him from examining the CD-ROM in full. It is interesting that the three students who reported using the CD-ROM from the moment it arrived (students 4, 6 and 8) used the CD-ROM to different extents. The reports of students 6 and 8 indicated a "window shopping" behaviour, where the initial exploration of the CD-ROM's content is a cost assessment exercise to determine what aspects would be useful to the study of the course, and illustrative quotations from one of these students' transcripts are given below:

> *Interviewer: Did you look at all the sections on the CD-ROM?*
>
> *Student 8: I didn't look at all the sections, no. I briefly glanced through them, I got the feel for the CD. but the main areas that I concentrated on were the structural areas and the, I think, in the sensory areas...*
>
> *Interviewer: And when was it that you actually came to use those sections?*
>
> *Student 8: It was a bit of having a look at it beforehand for general interest, and as a refresher, and also combining it with the text book open beside of me with the appropriate sub-heading highlighting what I was actually looking at on my PC screen...I think time constraints probably prevented me from getting too involved with the CD, because, you know, I was doing a lot of reading at the same time. And I think reading at a greater depth, so to speak, you know, would have doubled up on what I was reading in the text books, perhaps. I did think that was the case on one or two occasions, when I did look at the more advanced areas.*

Table 5.7: Use of all sections and use in relation to other course material

Student	All sections used	Use of sections in relation to other course material
1	-	-
2	Yes	Midst
3	No	During/After
4	Yes	-
5	Yes	After
6	Yes	Before/During
7	-	Midst/After
8	No	Before/During/After

5.4.3. Features of the CD-ROM

The third part of the interview explored students' use of and thoughts concerning the various features on the CD-ROM. A feature was determined to be a common aspect of each of the various sections on the CD-ROM, that is, graphics, text, narration, 3-layer structuring of information, Quick Test facility and the Objectives. It was interesting that as the interview shifted to examine these features, students started to refer to behaviours that could be interpreted as cognitive learning strategies.

Graphics

The CD-ROM made use of two types of graphic: static imagery in the form of diagrams or photographs and animated sequences. Two students (students 1 and 3) reported not being able to view the latter type of graphics either because of technical problems or hardware related incompatibilities. For most students the importance of the graphics was apparent. Student 1 indicated a particular expectation about using the graphics on the CD-ROM that could be considered a combination of two cognitive strategies – organisation and elaboration. The student also commented that he felt the CD-ROM failed in this respect (see excerpt below):

> *Student 1: What I would like to have done is use the images, the video part of it, as a kind of mental note to hang the text on, the text both from the CD ROM and the text from the printed material, so, you know, if you can't find one way into it, you can find another way into it, and then you can use that as a mental note, as an aide memoir, and I didn't think it worked like that, I didn't think it worked like that at all, for me.*
>
> *I How did you make use of the images in that current format, did you use them at all?*
>
> *PS Well, I looked through them, but I wasn't motivated to use them in the way that I think that I would have liked to have done, and I don't know whether or not that's because they were out of balance with the text, as far as I was concerned, or whether or not by that stage I'd got just too*

*p****d off with the whole deal, you know, but I do think that if it had been better written I would have used it more, and also used the text as a visual aid, sorry, I mean used the images as a visual aid, and I never saw any of the animated graphics at all because I kept coming up with the Shockwave error and there's no doubt about it, I'm running the latest version of Shockwave, and all that kind of stuff, but I never did see those animated graphics.*

This was probably the most critical comment passed about the CD-ROM.

A number of other students (students 2, 3, 4, 7 and 8) also described a cognitive, knowledge based strategy being used to study the graphic content of the CD-ROM. Commonly, these students described using this form of content to clarify, organise or elaborate upon the information from other course material.

Student 7: It made things clearer...some of the pathways [referencing physiology]...it was difficult to see where they were from the books in your mind...again it was back down to the long words...looking at the CD-ROM with diagrams and the different colours helped, it was easier to follow...it explained things simpler

Interviewer: Did you have those diagrams on the videotape?

Student 7: Yes we did but I think it was the fun of using the CD-ROM that got you into it a bit more...also with the video stopping and rewinding isn't quite as easy as clicking on a bit of the picture

Interviewer: What was the fun aspect for you?

Student 7: I think it was the novelty really...with the hands on the brain part I spent quite some time playing with it, turning it around when I didn't really need to...because you are there playing with you are getting it into your mind and the pictures there are [stored] longer...[the images and the video animation] were both brilliant because you could see it and see it falling into place...I liked seeing how the brain built up and how it all fitted together

Interviewer: How did the images and diagrams compare to those in the course texts or the video?

Student 7: From the text courses sometimes it was difficult to use your imagination to see what it would look like from the other side or even how the picture was built up...some of the CD-ROM graphics built up step-by-step so you could see what was underneath each other as opposed to just one picture and work it out for yourself.

Student 4 and 6 provided two contrasting comparisons of the graphics on the CD-ROM to those in the other course material. In the case of student 4, the organisation of the images and the presentation of the images on the CD-ROM was commented upon more favourably than the presentation of graphics on a video which also formed part of the course material. However, student 6 stated a preference for the presentation of graphics in the other course material, claiming she had a general dislike for the presentation format of computers.

Narration

The narration on the CD-ROM, essentially a sound file, was set to start playing immediately on the screen that it occurred. Although students were able to replay the narration once it had stopped there was no way of stopping the file once it started playing. This and the length of narration files irritated some students (students 2, 7 and 8). Student 7 and 8 elaborated on the negative aspects of the narration on the CD-ROM.

> *Student 7:[the narration] got on my nerves sometimes after a while...but it was quite good to have it there because some of the pronunciation obviously became clearer to hear somebody else say it rather than trying to read it out of the books...but the audio cassettes and the video helped with that as well.*
>
> *Interviewer: So why did it get on your nerves?*
>
> *Student 7: Sometimes it seemed to go on for too long...as if it were being read from a book...its difficult to say...if I was reading it I might have skipped a little bit I think that's the thing but if you are listening to someone you have to sit and listen until they are finished and you can't just skim the bit you want*
>
> *Interviewer: Is that the way you went through the traditional course material?*
>
> *Student 7: Not at the beginning because I tend to read the books quite thoroughly to start with but for the revision purpose and most of the CD-ROM was revising what I had done in the books...for revision you do tend to skim through and pick out the key words that you need and he was just going over and explaining over words...I was thinking come on lets just get to it.*

One positive feature of the narration mentioned by student 7 was that, in some circumstances, it helped with the pronunciation of technical terminology related to biological structures or functioning. Student 4 also made positive comments about this aspect of the narration. Other students (students1, 3, 5, 6 and to a certain degree 8) also reported liking the narration feature.

It is interesting to note that student 6 again makes a comparison of the narration on the CD-ROM to the other course material, just as she did with the graphics. This may indicate a facet of the window shopping behaviour, where part of the cost assessment exercise is in part a comparison of which medium, computer-based or non-computer-based, is a better reference source.

> *Interviewer: Did the narration help you study for the course?*
>
> *Student 6: Yes...in much the same way the TV and cassettes...you listened you made notes and played back...I used the narration in much the same way I used the audio cassettes*

Text

Study at a distance at the OU has at its core learning via course texts. Text was also included on the CD-ROM but it did not dominate the delivery of the material. Generally, text appeared in separate windows, to offer explanation of biological functioning or the relationship between various biological structures and processes. Also, text occurred in the form of text-hotspots, essentially links from diagram labels to more elaborated descriptions of that label. The comments about the text on the CD-ROM were generally positive. Students 1 and 5 stated that they would have like to have seen more detailed information in the text windows and hotspots, but generally the other students were pleased with the amount of detail included in the text. To a certain extent, the students differed in how they reported using the text in their study of the material on the CD-ROM. For example, students 2, 5 and 8 used the text to clarify and support the information that appeared in the course texts. Student 4, however, reported that with greater experience of using the CD-ROM she became more selective in terms of what text she read or attended to. For student 7, the text hotspots were an important feature in using the CD-ROM in that they indicated areas of the subject matter that she believed to be important. In contrast, student 6 reported making little use of the hotspots.

> *Student 7: I liked the hotspots that was part of the fun of it again...it highlighted areas that obviously were important other wise they wouldn't have been there...I particularly liked the idea of different colours to say you had been there because at the start I kept on going to same ones all the time...but that was me not remembering I had been there...they were quite useful in highlighting areas I should pay more attention to*
>
> *Interviewer: Was it picking up information that you possibly skipped in the other texts?*
>
> *Student 7: Yes certainly...on one or two occasions there things that I though 'ooh I didn't realise that from the [course] texts or even from the video, I somehow missed it*

> *Student 8: I I thought it supported, you know, it was brief enough to read and compare it with the visual image. I was also... I also found that I was making comparisons with what was written on the screen with what was written in the text books. Yes...it represented it quite well.*
>
> *Interviewer: When you were making those kind of comparisons were you comparing primarily information on the screen to the book or the other way around, would you take the information from the book and compare it to that on the screen?*

Student 8: Probably a little bit of both actually. I don't think I favoured one or the other, I kept it pretty much down the middle, I think, on most occasions.

Quick Test Facility

Student 1 was the only student out of the eight not to have used the self-testing system of questions on the CD-ROM. Two of the students reported using the Quick test facility for revision (students 2 and 4) and in particular student 4 reported using the questions more towards the end of the course specifically for revision. For student 3 a positive aspect of the questions included on the CD-ROM were that they were easier to understand and presented in plainer language that those that appeared at the end the course text chapters. For students 5 and 7 the questions served as a gauge of what they had learnt from the CD-ROM, with student 7 reporting that answering the questions correctly served to boost her confidence in understanding the material. In contrast though, student 6 reported that not being able to answer the questions correctly led to her becoming confused about what she had learnt and overall did not see great benefits to their inclusion on the CD-ROM when it came to her own learning experience. However, student 6, along with student 7, reported going back through the material on the CD-ROM when they did get an answer to a question incorrect.

Objectives

Learning objectives are a common feature of the required reading material, appearing at the end of each chapter of the course texts. Questions about the objectives that appeared on the CD-ROM for each section prompted some interesting findings about how these were used with the course texts and how this behaviour also transferred to the CD-ROM. Student 1 reported not using the objectives that appeared on the CD-ROM at all, instead he reported behaviour similar to that of students 6 and 8 in their use of the various sections, that is, "window shopping". Three other students (students 4, 6, and 7) also reported not using the objectives and they all explained that this was because they rarely examined the objectives in the course texts either. Student 4 talked about setting

her own objectives for each section rather than following those prescribed by the CD-ROM, again this reflected her behaviour in studying with the course texts. In contrast, students 2, 5 and 8 reported that the objectives on the CD-ROM actually helped to guide them through the various sections of the CD-ROM.

> *Student 8: I used the objectives as a sort of introduction to the area that was going to be presented, yes.*
>
> *Interviewer: So you looked at those before you looked at the section?*
>
> *Student 8: Yes, oh yes. Well, initially I did, and then as I became more competent with the CD, I was going straight into the area that I particularly wanted to look at, whether it was a sizable area or a smaller area, I was using it like any other interactive CD really, that I've got others in my collection.*
>
> *Interviewer: So did the objectives help guide you through the sections?*
>
> *Student 8: I thought so, yes. Once I was aware of what they were stating so to speak, once I got a grasp of that I, as I say, I was confidently going into the other... I was using the index on the CD more than going into the major headings, and I was going into the index listing and highlighting particular areas and going straight into that come the end. I found that quite, you know, more useful to me in fact than sort of wading through individual sub-sections. You know, there was an index column, you know, that you could sort of click on and go straight into a section that that particular word or description applied to, and you could go straight into it, as I recall, and that was... you know, I was using the CD that way come the end.*

Three-layered structure

In the questionnaire the majority of students reported that they did not find the three-layered structuring of the information limiting when going through the contents of the CD-ROM. However, in the interviews a number of students expressed the view that this organisation of the information in terms of multiple screens was at times confusing (students 4 and 7, see excerpt below). Student 6 argued that the difficulties she encountered with the organisation of the information on the CD-ROM could have been overcome if the structure of the content was the same as that in the core texts. This indicated a comparison of the course texts and the CD-ROM which was also commented upon by Student 7 who appeared to try and want to use the CD-ROM like a linear piece of text:

> *Student 7: Some of the time I was going to bits I really didn't want to with that...it was a waste of time at the beginning...it gave you more detail...sometimes I got into parts I didn't want to be in or wasn't ...there was one day I was looking for something in particular and I couldn't find it and I still couldn't find it in the end I kept on getting into the level 3 and took time trying to get back to level 1...it was probably because I was looking for something that wasn't even on the CD-ROM...I felt that I had to backtrack all the time... then I would forget where I had been and ended*

going there again still looking for the same thing...I couldn't find a way of going across I had to keep going backwards...from the level 3 back through level 2 and then 1 and it just seemed to waste my time then...maybe its practice

Interviewer: Did you feel frustrated about that at all?

Student 7: I did a little bit...as I said this day I couldn't find what I wanted so back to the books

Interviewer: So when you were looking through the 3-layered structure were you sometimes going through looking for specific aspects?

Student 7: Sometimes yes...just like a book...just browsing

5.4.4. Tool use, note-taking and other activities

The CD-ROM contained a series of tools designed to enhance the learning experience with the computer. In the interview the use of four of these tools was explored: the Glossary, the Notepad facility and the Camera and Album facilities.

The Glossary

Student 1, 2, 4 and 7 reported having a look at the Glossary but failed to make any real use of it in either their study of the CD-ROM or the course in general.

Interviewer: The CD ROM also makes use of various tools...How did you come to use these in your study, if at all? The Glossary.

Student 1: I think I fired it up, realised it was going to be no use and then closed it down.

Those students who did use it found it easy to access and operate (student 3) and used it to reference information on the CD-ROM and the course material (students 5 and 8). Student 6 gave an interesting insight into the use of a computerised glossary from the perspective of a mature student who had been taught in her school career to use glossaries and liked using them.

The Notepad and note taking

Only two students reported using the Notepad facility (students 3 and 5) with their use of the word-processing facility being limited to making specific references to aspects of the CD-ROM content. These two students, along with students 5, 6, 7 and 8 reported making hand-written notes from the CD-ROM content. Although many students did not explain the reason why they did not use the Notepad facility a possible explanation may come from students 5 and 7 who commented that they preferred making hand-written

notes since these were portable. Student 7 reported not using the facility because of her lack of computer experience and student 4 could not use the facility on her home computer. Students 7 and 8 reported that the types of notes they made were integrated with the notes they took from the other course materials. Students 2 and 4 made no notes from the material on the CD-ROM at all. This would seem to suggest that the activity of note-taking with the CD-ROM is a cognitive one where information is screened, selected and organised for later reference.

Interviewer: Were you making your own notes?

Student 7: Yes I was...pen and paper...because then I could take it away also I work with my books beside me and I used to make a lot of notes in my books

Interviewer: From the CD-ROM what kind of notes were you taking and where were you taking them from?

Student 7: I tended to take the books that were relevant with me so I knew which bits I wanted to look at the time...I made notes whilst I was there from the CD-ROM...but anything on the CD-ROM is in the book anyway it just makes it clearer. Diagrams...they were useful to reinforce what I learned on the diagrams and also the pathways...it helped you understand those much more so I would take notes to understand what the pathways do...mostly it was the pathways I took notes about

Camera and Album

The CD-ROM provides students the ability to cut and paste screens using the Camera and Album tools. No students actually used these tools whilst studying the CD-ROM. A number of students reported not using them because they felt that a lot of time was needed to make proper use of them and they questioned the tools' usefulness anyway in terms of studying the content of the CD-ROM (students 1, 2, 6, 7 and 8). However, these students did report having a look at the Camera and Album just to see what they did. Students 3 and 4 reported that they failed to use these tools because they were unable to figure out how they worked which they attributed to their lacking of computing expertise or experience.

Interviewer: You didn't use. the Camera or the Album. Could you tell me why that was?

Student 2: I just felt that that was adding extra stuff on that I didn't want, it's an extra workload, or would have meant an extra workload to use those things.

Student 7: I had a look at them but didn't really use them...they didn't really help with my work...I didn't spend a lot of time with them... I saw what they did and then moved on.

The following section details how the reports of students were categorised according to dominant themes and the computer-based learning strategies that were interpreted from these themes.

5.5. Discussion

The main purpose of the study reported in this chapter was to identify the learning strategies students adopted in their use of the CD-ROM. A second aim was to determine how these strategies compared to those students used in the study of traditional course material.

The previous section of this chapter detailed some of the general themes that emerged from the students' reported use of the CD-ROM. This section details the framework of strategies that were found from the analysis and compares different students' reports of using the CD-ROM.

Initially, each student's transcript was examined and the dialogue was assigned to one four categories. The first of these referred to general information about studying the course collected in the first part of the interview. The information in the remainder of the interview was separated into accounts of what motivated the student to the use the CD-ROM, what they did with the information on the CD-ROM and how they generally dealt with using aspects of the CD-ROM and the tool overall. These themes reflected the three classes of behaviour identified in the conceptual framework underlying the MSLQ, that is, motivation, cognition and resource management. The dialogue that comprised each of these themes was further scrutinised for evidence of specific strategies, initially those identified in the MSLQ framework for that particular class of behaviour. The data was then searched for any discrete behaviour that could be identified as strategic behaviour.

The behavioural findings from each of the individuals were then compared across the group of students interviewed in this study. The purpose of this comparison was to establish common themes or strategies. There was no common behaviour in any of the reports that could be identified as being similar to the MSLQ strategies. Therefore, a

novel computer-based strategy was made on the basis of two criteria. Firstly, behaviour or utterances had to be made by more than one student. Secondly, because strategies as constructs typically represent a continuum, behavioural instances that were conflicting but mentioned in the same context of using the CD-ROM were also considered evidence of strategic behaviour. For example, some students reported making hand written notes from the CD-ROM whilst other students reported making no notes, this different approach to using the CD-ROM was identified as a Notetaking strategy. Again reports of these different approaches had to be made by two or more of the students interviewed.

This process revealed a series of strategies, twelve in total, which will be discussed in detail in the following subsections of this chapter. These behaviours and practices could be categorised into the same broad types as traditional strategies (i.e. motivation, cognitive and resource management) but the component strategies of these classes were different from those in the MSLQ framework.

5.5.1. Motivational Strategies

In the interviews students reported being motivated to use the CD-ROM for a number of reasons and what emerged were four motivational strategies that were linked to the use of the CD-ROM. These strategies cannot be said to be relevant to all the students but this still adds to the understanding of that individuals' learning experience.

Three of these strategies emerged when the students were asked why they had chosen to use the CD-ROM and three main reasons were given. These included the fact that it was a piece of IT and thus a valued commodity, another reason why some students used it was because it was supplied along with the other course material. Others reported a set of expectations that using the CD-ROM would be beneficial to their study of the course. These strategies account for the why the CD-ROM was used in the first place. However,

from asking students about the features of the CD-ROM, a strategy also emerged that saw continued use of the CD-ROM being encouraged by the presentation of the information on the CD-ROM.

In terms of the framework of strategies proposed by Pintrich et al, these strategies were related to two general components of motivation, that is, value and expectancy. In the MSLQ framework 'value' refers to why a student performs an academic task and is related to a set of personal goals and the value they attribute to the study of the course material. 'Expectancy' refers to an appraisal on the part of the individual in their ability to complete the task at hand, most often the successful understanding and study of the course material. Various strategies fall under these components in the MSLQ framework but these did not emerge in the analysis. Instead, in terms of value, use of the CD-ROM seemed to be motivated by both a level of value attached to using the technology and the aesthetics of the features on the CD-ROM, that is, the graphics, text and narration. Expectancy in terms of the CD-ROM was linked to expectancy for success on the course generally and the understanding of the course material. This expectancy appeared for most of the students to be quite low. Therefore, some students also reported using the CD-ROM in an attempt to increase their understanding of the course content.

Perceived value of IT

In talking about their reasons for using the CD-ROM students 1 and 5 indicated a general belief that information technology is a useful and valuable resource and that the CD-ROM was used because it was part of that technology. Interestingly, student 1 was a daily, enthusiastic user of technology whereas student 5 was a less confident and infrequent user of the technology. This strategy certainly needs further investigation but is important in its conceptualisation because it indicates that a proliferation of computer

technology, especially in the home, strengthened the position and use of the technology as a learning tool.

Presentation format

At some point in their interview, all the students compared the way information was presented on the CD-ROM to the way it was presented in the text based course material. The format that students referred to was the combination of textual, pictorial and narrative information. For some students, the format of the CD-ROM presented a learning advantage or was more engaging (students 3 and 8) and it motivated them to continue using the CD-ROM. For other students the format was cumbersome and inhibited learning (students 1 and 6), leading them to limit their use of the CD-ROM.

Resource exploitation

Students 2, 5, 6 and 7 reported being motivated to use the CD-ROM because of its availability as part of the course material. What was also common amongst these students was that they would typically use or examine all the available course material. Whilst this may not seem unusual, the other students reported that they tended to concentrate on the text with some reference made to audiocassettes and video material. For some students the examination of all course material was linked to a belief that they were likely to fail the course unless all the available course material had been examined to some extent.

Expectancy

Students 1, 5, 6 and 7 reported a set of expectations that they initially had had about the CD-ROM even before using it. These expectations typically included notions about how the information on the CD-ROM would clarify concepts and add to their understanding of the subject matter presented in the other course material. Such expectations motivated the students to use or explore the CD-ROM. These students also reported that

they hoped that initially the CD-ROM would make the information clearer than the books and more interesting to study and learn about.

5.5.2. Cognitive Strategies

In the framework underlying the MSLQ, the cognitive class of strategies includes mainly information processing behaviours but also metacognitive awareness. The conceptualisation of information processing strategies by Pintrich and colleagues is based on that of Weinstein and Mayer (1985) and their notion of a set of behaviours dedicated to the encoding and storage of information. These behaviours are identified as rehearsal (repetition), elaboration (consolidation of existing information with new information) and organisation (selection). These facets of strategic behaviour are well defined and their identification is relatively straightforward. In comparison, metacognitive behaviours and processes often remain elusive (Pintrich, Wolters and Baxter, 2000).

The data collected from the eight students was initially examined for evidence of information processing related strategies as identified in the MSLQ framework. There was little indication of the specific strategies distinguished by Pintrich and colleagues. Therefore, the data was examined again for evidence of behaviour that related to the understanding and encoding of information. In doing so, four cognitive strategies emerged that were used by all the students interviewed, although to varying degrees.

Knowledge Focused

This strategy had two main components: increasing understanding and increasing clarity. With the exception of Student 1, all the students reported that they had used the CD-ROM to build on what they learnt from other course materials, particularly the text based course material. Also, the information on the CD-ROM was used to clarify the information from other sources. This behaviour was often mentioned when students were asked about the various features of the CD-ROM.

Self Testing
This strategy refers not only to the use of the Quick-Test facility on the CD-ROM but also how students reported using this feature. That is, with one exception (Student 1) students reported using the Quick-Test facility as method of testing what information they had learnt, a kind of checklist.

Objectives
This strategy was indicated to be very similar to that of Self Testing in that it gave students an opportunity to compile a checklist of what they ought to learn. Again the strategy refers not only to the use of this feature on the CD-ROM but the purpose of its use. For those students that used the Objectives on the CD-ROM (Students, 2, 5 and 8), they served as introductions to areas and were viewed before a section was started. This behaviour reflected how these students used the objectives that appeared in the text based course material. The use, or non-use of the Objectives on the CD-ROM also reflected the students' use of the objectives in the text based course material.

Notetaking
In some cases students reported taking notes from the CD-ROM (*i.e. Students* 5, 6, 7 and 8) and this indicated a learning strategy termed Notetaking. These notes were used to clarify or expand upon the information from the course material. This behaviour could be related to the Knowledge Focused strategy but Notetaking is considered a strategy in its own right because students mentioned it as an activity distinct from that of information processing.

5.5.3. Tool Management Strategies
In the MSLQ framework a set of strategies are considered to account for the students' management of the resources available to them. This group of strategies reflects how the students adapt and work in that academic context and are referred to as Resource Management strategies. In examining the use of the CD-ROM, a series of four strategies also emerged but these were specific to managing the CD-ROM. These were termed

Tool Management strategies because collectively they reflect not only the management of the resources available on the CD-ROM but also the general conceptualisation of the technology as a learning tool.

Modality preference

In the interview, when students were asked about the various modes of presenting information on the CD-ROM, i.e. graphics, text and narration, their responses fell into a number of basic categories. At one extreme some students (for example Students 5 and 6) reported that all the modes of presentation were equally favourable. However, other students reported that they had a particular preference for two out of the three presentation modes. For example, Students 7 and 8 reported that they preferred the graphics and text to the narration; whereas, Students 2 and 4 reported a preference for the narration and graphics. In most cases there was a strong preference for the graphics, with least preference given for the narration. The implications of this preference require further investigation but could indicate that students attend to the graphics to a greater extent than either the text or the narration. This maybe because understanding of the subject matter, in particular the physiological structures of the central nervous system, is supported best by visual representations of those structures.

Window Shopping

In the interviews, the reports of students 6 and 8, revealed a "window shopping" strategy. This strategy appeared to be characterised by an initial exploration of the CD-ROM's content as a cost assessment exercise to determine what aspects would be useful to the study of the course. This occurred, as the students themselves reported, before they "used the CD-ROM properly". Other students reported no such behaviour, instead they worked through an entire section and did not question the usefulness of that section's content.

Navigation

The formulation of this strategy was prompted by responses to questions concerning the three-layered structuring of information. Most students said very little about the positive aspects about this organising feature, instead they reported frustration at not being able to locate information they wanted and becoming lost in the layers as in the case of Students 4, 6 and 7. A number of issues need to be further investigated in relation to this strategy. Specifically, what happens as a result of getting lost and whether students give up looking for the information they were originally searching for. Also, further investigation is required of the Index system on the CD-ROM and its impact on strategic behaviour since this facility is intended to assist students in their navigation of the information on the CD-ROM.

Tool Use

In the interview students were asked about their use of various Tools on the CD-ROM, i.e. the Camera and Album facility, the Glossary and the Wordpad facility. Most students reported not using these tools. The students reported examining the tools but reported they added little to the learning experience or would take too long to learn how to use properly. This translates into a strategy where the focus is on evaluating the Tools, with their use an outcome of this process. Further understanding of this process would be useful in accounting for the use of similar optional extras in other learning environments.

5.6. Summary

The main aim of the study reported in this chapter was to determine the nature of students' learning strategies when using the CD-ROM. In examining the reports of eight students about their experience of using the CD-ROM, twelve learning strategies or study practices emerged:

***Motivational Strategies*:**

Perceived value of IT

Presentation format

Resource exploitation

Expectancy

***Cognitive Strategies*:**

Knowledge focused

Self testing

Objectives

Notetaking

Tool Management:

Modality preference

Window shopping

Navigation

Tool Use

Another aim was to examine how these strategies compared to conceptualisations of learning strategies used in the study of traditional course material. In an earlier study traditional learning strategies were examined using the Motivated Strategies for Learning Questionnaire. Using this instrument's underlying conceptual framework of strategies as a comparison, the individual strategies identified in this study are different from those identified by Pintrich and his colleagues.

This study offers an initial insight into the nature of strategic learning using information technology, however further investigation is needed of the constructs both on a larger

scale and in greater detail. Two further studies were designed to do this and are reported in subsequent chapters that attempt to address these research aspects.

Chapter 6

STUDY III: MEASURING LEARNING STRATEGIES IN A COMPUTER-BASED LEARNING ENVIRONMENT USING THE SPOTLITE QUESTIONNAIRE

6.1. Introduction

This chapter reports on the third in a series of studies that examined the nature of students' learning strategies when learning with computers. The previous chapter reported on Study II where eight students who used the Human Brain CD-ROM were interviewed. This set of dialogues uncovered a series of behaviours and processes relevant to working and studying with the CD-ROM. These behaviours were formalised into a framework of learning strategies.

The purpose of the study reported here, Study III, was to refine and further explore that initial framework by developing and testing a questionnaire (copy included in Appendix E) intended to examine the computer-based learning strategies of students. Whilst the interview approach to collecting data provides more detailed information it is based on a smaller, potentially less representative sample of the population being investigated. The study reported here was able to examine the findings from the study reported in the previous chapter with a much larger and broader sample. The findings from the questionnaire were analysed using both item analysis and factor analysis. The two techniques revealed a series of strategies that are detailed in the latter half of the chapter.

6.2. Method

6.2.1. The questionnaire

The SPOTLITE questionnaire consisted of four sections. The first three sections concerned learning strategies. The first section was intended to measure the motivational strategies that accounted for why the Human Brain CD-ROM was used. The second section was intended to measure the cognitive strategies adopted in using the CD-ROM, i.e. how students dealt with the information on the CD-ROM. The third section was intended to measure Tool Management strategies adopted in using the Human Brain CD-ROM. A final section was included with the intention of framing and providing a context to the strategic behaviour of students. This section included questions relating to the amount of time spent using the CD-ROM and the sections used.

The questionnaire consisted of 72 items designed to examine the strategic behaviour of students in the use of the CD-ROM. The motivation section of the questionnaire comprised 17 items, the cognitive section, 22 items, and the tool management, 33 items. The questions were based upon common phrases or utterances reported by the students in Study II. A four-point Likert scale was used to respond to each question, the points were marked as follows: 1=not all true of me; 2=not very true of me; 3=fairly true of me; and 4=very true of me.

The final section of questions examined students' general experience of using the CD-ROM including information relating to the amount of time they spent using the CD-ROM. This final section also gave students the opportunity to provide contact details if they were willing to be interviewed about using the CD-ROM, providing a sample pool for Study IV. Students who had not used the CD-ROM were also asked to comment on their reasons for not doing so.

6.2.2. Participants

The questionnaire was sent to a random sample of 500 students, just under half the course intake that year, from across the OU regions. Two-hundred-and-forty students returned the questionnaire and of that sample, 140 indicated that they were using the Human Brain CD-ROM. The mean age of those who reported using the CD-ROM was 37.9 years (SD=9.66), 33.6% of the sample were male (n=47) and 66.4% were female (n=93). Table 2 shows the proportion of students from the various Open University regions in Great Britain who reported using the CD-ROM.

Table 6.1: Sample of CD-ROM users in terms of OU regions

Region	Freq.	%
1	9	6.4
2	11	7.9
3	12	8.6
4	8	5.7
5	8	5.7
6	18	12.9
7	8	5.7
8	11	7.9
9	11	7.9
10	3	2.1
11	17	12.1
12	12	8.6
13	12	8.6

6.2.3. Procedure

The course that students were studying began in February 1999. By the end of March all the students on the course had received a copy of the CD-ROM. The CD-ROM was presented to students as an optional piece of course material, and the precise number of students who would use the CD-ROM was unknown. An earlier study, Study I, indicated that approximately fifty percent of students had used it in the group of students who had studied the same course the year before.

The questionnaire was sent to students in August giving most students enough time to have used the CD-ROM and therefore be able to complete the questionnaire.

6.3. General Findings

This section discusses the analysis of responses to questions in each of the three learning strategy sections of the SPOTLITE questionnaire. The responses of the 140 students who used the CD-ROM were initially analysed using Item Analysis (to determine that items measured the general types of behaviour they were intended to measure) and then using Factor Analysis (to determine specific learning strategies in each of the sections of the questionnaire).

The section begins by presenting data from the final section of the questionnaire. This part of the questionnaire was intended to provide general information related to using the CD-ROM and frames students' responses to the learning strategy sections of the questionnaire. The findings of the Item Analysis for each of these sections are presented first, followed by the Factor Analysis. The section ends by presenting the descriptive figures for the strategies that emerged from the Factor Analysis, the correlations between strategies and the reliability of these constructs when examined statistically.

6.3.1. General Findings

Responses to questions in the general section of the questionnaire are presented in Table 6.2. There are two important findings that are relevant in considering the strategic behaviour of students: their experience of using computing technology prior to using the CD-ROM and the time spent using the CD-ROM.

A large proportion, 95% of the sample, had used a computer prior to using the CD-ROM (133 students). Half the sample reported using a computer at both home and their place of work, 42% (59 students) reported using a computer purely in their own home. Most students, 60% (84 students), reported using a computer on a daily basis, with only 3.6% (5 students) reporting that they did not use a computer often. A majority of students, 91.4% (128 students) reported using their computer at home or at work to run

general software such as Microsoft Word and Excel. More than half the sample, 55.7% (78 students), reported using their computer for communications, i.e. email, and the Internet.

In terms of time spent using the CD-ROM, 52.6% of the sample (72 students) spent five or less hours using the CD-ROM; 29.2% (40 students) spent between 6 and 10 hours. A smaller proportion of students used the CD-ROM for a longer period of time, 8.7% of the sample (12 students), spent between 12 and 18 hours using the CD-ROM and 9.5% (13 students) spent more than 20 hours using the CD-ROM. These figures indicated that almost 80% of the sample spent ten or less hours using the CD-ROM when it is intended that it should provide about thirty hours of study activity.

Table 6.2: General computing experience

Item	Freq.	%
Had you used a computer prior to using a computer?		
Yes	133	*95.7*
No	6	*4.3*
In what location(s) do you use a computer?		
At home	59	*42.1*
At my place of work	7	*5*
Both home and work	70	*50*
At some other location	2	*1.4*
For what purposes do you generally use a computer?		
To run general purpose software (e.g. word processing, spread sheets) and printing	128	*91.4*
To run specific commercial software	48	*34.3*
Communications (i.e. e-mail)	78	*55.7*
Internet/World Wide Web	78	*55.7*
Is this the first time you have used a multi-media CD-ROM on an academic course?		
Yes	118	*84.3*
No	21	*15*
In what location(s) did you use the CD-ROM?		
At home	108	*77.1*
At my place of work	11	*7.9*
Both home and work	13	*9.3*
At some other location	6	*4.3*

The CD-ROM contained seven sections related to the study of the course Biology, Brain and Behaviour, these included: the Overiew (a general introduction); Hands on the Brain (a 3D model of the brain that allowed students to view specific aspects of brain physiology), the Cerebral Cortex, the Spinal Cord, Vision, Hearing and Speech. Each of the sections on the CD-ROM was studied by more 60% of students as shown in Figure

6.1. The sections students used the most were the Overview used by 95.7% (134 students), the Cerebral Cortex used by 89.3% (125 students) and the Spinal Cord used by 85% (119 students). The least used sections were Vision, Speech and Hearing, yet these were still examined by more than 70% of the students who used the CD-ROM.

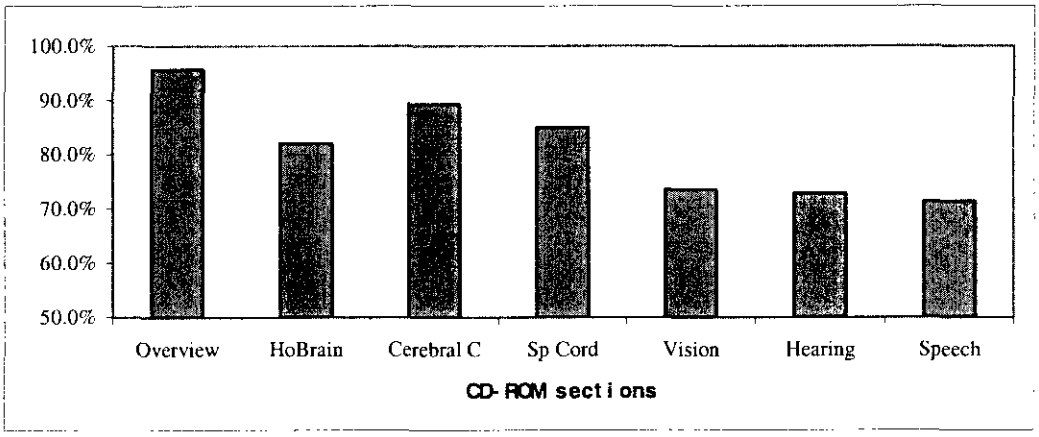


Figure 6.1: Use of sections on the CD-ROM

6.4. Findings from Item and Factor Analysis

The SPOTLITE questionnaire was divided into three sections in order to measure three classes, or types, of learning strategy: Motivation, Cognitive and Tool Management. The responses to items in each of these classes were analysed initially using item analysis and then factor analysis. The purpose of the statistical techniques was to identify groups of questions that could be interpreted as individual strategies in each of the strategy sections of the questionnaire. The following sections of this chapter (6.4.1., 6.4.2 and 6.4.3) examine which factors or strategies emerged from each of the strategy sections of the questionnaire. Section 6.4.4 examines to what extent these strategies were used by students by examining the mean response given to those questions that indicated a particular strategy. Section 6.4.5 then examines how these individual strategies correlated with strategies from the same section of the questionnaire and other sections.

Item analysis was used to determine if the questions, for example, included under the Motivation section of the questionnaire, actually measured motivation to use the CD-ROM. The rationale underlying this type of analysis is that if a test is measuring a particular behaviour then each item that comprises that test must also measure that variable. To establish this, two statistics were produced for each item in the three learning strategy sections of the questionnaire: the proportion of the keyed response and the correlation of individual items to the total score in that section.

For a question to pass as an acceptable item of the test in which it appears the percentage of keyed responses has to be between 20% and 80%. The keyed response is the reply expected in relation to a question if the respondent identified with, or demonstrated, the behaviour measured by the overall test. Thus to the question 'I want to do well on the course' as part of a test examining motivation to student, the answer of

'yes' or a positive response on a Likert scale would be the keyed response. The question should also correlate with the total score, with a observed value of 0.3 or above. In the strictest sense, both these criterions should be met, however, the inclusion or rejection of an item in a test is ultimately left to the discretion of the test designer.

Tables for each of the three sets items that include the keyed response and total score correlations are included in Appendix F (see tables F.1 for Motivation questions, F.2 for Cognitive, and F.3 for Tool Management).

If Item Analysis indicates whether questions measure the same thing collectively on a test, then Factor Analysis determines, very simply, what the different parts of the test are and which questions relate to those parts. Three separate Factor Analyses were performed, one for each set of items from the three learning strategy sections of the questionnaire. In brief, the Factor Analysis was carried out using the Principle Components method, extracting oblique, related factors with the number of final factors determined by a Scree Test. These factors were then rotated using the direct oblimin rotation method. A more detailed discussion of the techniques appears in Chapter 3 of this thesis.

A Scree Test was used to determine the number of factors to extract and revealed four viable factors for each of the three sets of questions (see Appendix G).The next stage of the Factor Analysis process was to map each set of items on to the major constituent factors to determine the exact nature of these factors. This was accomplished by rotation, which determines the correlations between items and factors presented as a table of factor loadings. A factor loading of 0.5/-0.5 or above was considered to be significant based on the size of the sample (Hair, 1984). The factor loadings appear as both negative and positive figures, but these have no bearing on the nature of the factors themselves, the interpretation of a factor being significant is all that can be achieved

from these figures. The factor loadings for each of the three sets of items are presented in Appendix H. Factors were identified as particular strategies on the basis of the items that loaded on to factors.

In the first part of the next section, the findings from both the Item and Factor analyses are presented for each class of strategy. The constituent strategies for each class are also identified and discussed. The latter part of the section discusses these strategies in terms of the extent to which they were used, how strategies from different classes correlated with one another and how reliable these notions of study behaviour are.

6.4.1. Motivational Strategies

Item analysis indicated that one item, Q1 (below) had a correlation of below .25 with any of the other items in the motivation set of items. This item was also not included in the set of items that were factor analysed. A possible reason why this question did not correlate with the other items is that it points to curiosity being a motive to use the CD-ROM whereas the other questions centred on personal beliefs being the motive for using the CD-ROM.

> *1. I used the CD-ROM because I was curious about how the information would be presented*

In total then, 16 items were included in the factor analysis. The overall model accounted for 59% of the variance in the set of items. Four motivational strategies emerged, these included: Presentation Format, Resource Exploitation, Perceived Value of IT and Expenctancy.

FACTOR I – Presentation Format

The eight items below loaded on to the first factor (Q3, Q4, Q5, Q7, Q9, Q13, Q14 and Q15).

> *3. I expected the CD-ROM to make it easier to understand the information in the books*

4. I expected the CD-ROM to give me an idea of what were the important concepts I had to learn about from the other course materials
5. I used the CD-ROM because it allowed me to examine biological structures and processes in a way that I could not with the audiocassettes, video and the model of the brain
7. I believe one reason why computers can be considered useful is that they can present information differently from books
9. I expected the information on the CD-ROM to make it easier to understand the information from the audio cassettes, video and model of the brain
13. I used the CD-ROM because it made topics easier to understand compared to the other course material
14. I decided to start using the CD-ROM because I thought it would make the topics I was studying clearer
15. I used the CD-ROM because it allowed me to examine biological structures and processes in a way that I could not with the books

The questions that loaded on to the above factor indicate that students used the CD-ROM because they believed it offered an easier alternative to the other course material. The appearance of Q7 in this set of questions also indicates that this is linked to a general belief about the advantage of presenting information via computer-based technology than traditional distance learning materials such as books and videos. Overall, the grouping of questions above indicate that this strategy was linked to the manner in which information is presented on the CD-ROM, its format, hence this motivation being called Presentation Format.

FACTOR II – Resource Exploitation

The three items below loaded on to the second factor (Q8, Q10 and Q17).

8. I generally like to make use of all course material
10. I decided to start using the CD-ROM because it was available
17. I used the CD-ROM because it was part of the course materials

The second factor to emerge from the Factor Analysis was identified as the strategy Resource Exploitation. The items that loaded on this factor indicated motivation to use the CD-ROM arose because of a perception that it was necessary to use all course material. This may indicate a larger motivational strategy related to the study of the course in general and the use of course materials.

FACTOR III – Perceived Value of IT

The four items below loaded on to the third factor (Q2, Q11, Q13 and Q16).

2. I think computers make information more accessible than books
11. I think computers offer advantages when it comes to learning and studying
13. I used the CD-ROM because it made topics easier to understand compared to the other course material
16. I think computers are beneficial in everyday life

This strategy was identified as the Perceived Value of IT and indicated that students used the CD-ROM, in part, because of a general potential attributed to IT. The loading of Q13 on to this factor may seem a little out of place, with the item probably best suited to account for Factor I, the Presentation Format strategy, where it also loaded. However, Q13 also indicates a potential related to using the CD-ROM that would account for its loading on to this factor also.

FACTOR IV – Expectancy

The final factor in the Factor Analysis of the motivational items was identified as Expectancy, the following three items loaded on to the factor, Q6, Q7 and Q12 (shown below):

6. I expected the CD-ROM to provide additional information to the books
7. I believe one reason why computers can be considered useful is that they can present information differently from books
12. I expected the CD-ROM to provide additional information to the audio cassettes/video.

This factor indicates a motivational strategy that prompted the use of the CD-ROM because of a set of assumption held about the benefits of using such a tool. Questions 6 and 12 indicate that a main expectation of students was for the CD-ROM to provide additional information to the other course material. However, use of the CD-ROM may have also been prompted by a general expectation that computers make information more accessible than books, as indicated by question 7. Thus, according to this strategy, students used the CD-ROM because they expected it to offer some kind of learning advantage.

Dual Loadings

There were two instances where items significantly loaded onto two factors, i.e. Q13 and Q7 (shown below). Both questions appeared in the set of items that loaded on to the first factor, the strategy Presentation Format. Question 7 also appeared in the set items for the fourth factor, termed Expectancy. Question 13 also appeared in the item that emerged for the third factor, termed Perceived Value of IT.

> *7. I believe one reason why computers can be considered useful is that they can present information differently from books*
> *13. I used the CD-ROM because it made topics easier to understand compared to the other course material*

Dual loading is a common occurrence and indicates the item could as easily be accounted by either factor. This identifies the importance of following Item Analysis with Factor Analysis, since the former technique could not identify this occurrence. In such an event it is usual to consider the item as being unsuccessful in loading on to any item or, at the discretion of the researcher, to make a decision about which factor the item loads best. In the current analysis it was decided to consider such items as successfully loading onto both factors in the belief that doing so, in light of so few items for this section, would add to the understanding of each strategy.

6.4.2. Cognitive Strategies

Item analysis led to Q22 and Q26 (see below) being excluded from the set of Cognitive related questions that were factor analysed.

> *22. I went through a topic on the CD-ROM before looking at it in the other course material*
> *26. I made notes using the Notebook word processing facility on the CD-ROM*

In the case of Q22, the item did not correlate highly with the rest of the set, this could be attributed to the fact that question refers to Tool Management behaviour rather than information processing behaviour. Question 26, however, produced acceptable

correlations with the other items in the set but had a low proportion of the keyed response. That is, only 8.6% of the sample responded with a 3 or 4 to this question. This indicates that most of the students did not use the Notebook on the CD-ROM and this item has little discriminatory power. Unlike the other questions in the Cognitive related section of the questionnaire, it did not provide a spread of scores between 1 and 4.

Following the item analysis, 20 of the original 22 Cognitive strategy questions were submitted to factor analysis. The overall model explained 63% of the variance in the set of items analysed. Again four strategies emerged from this section of the questionnaire, these included: the Knowledge Focused strategy, Self Testing, Notetaking and the Objectives strategy.

FACTOR I – Knowledge Focused

The six questions below loaded on to the first factor (Q18, Q24, Q28, Q30, Q34, Q36).

> *18. I found the information on the CD-ROM increased my understanding of the information in the books*
> *24. The CD-ROM increased my understanding of the information from the audiocassettes, video and the model of the brain*
> *28. I used the CD-ROM alongside the books to help me to understand the topics I was studying*
> *30. I used the CD-ROM to give me an idea of what were the important concepts in the other course material*
> *34. I used the CD-ROM to look up specific items of information*
> *36. I would look at relevant sections of the CD-ROM after I had studied the course material*

This factor, Factor 1, was identified as a Knowledge Focused strategy. The grouping of questions indicated that students were primarily using the CD-ROM to enhance their understanding of the subject area. In that sense the CD-ROM fulfils its intended purpose but this grouping of questions also suggests that the CD-ROM was used to clarify concepts that appear in the other course material. Thus, a picture emerges of students using the CD-ROM as a tool that supports their learning from the other course material. The other course material forms the basis of their learning. This and the average amount of time that students reported spending on the CD-ROM has implications for any future

plans for it to replace any of the existing course material. That is, students do not appear to place an emphasis on the CD-ROM as a learning tool. However, at the time of the study it was clearly pointed out to students that the use of the CD-ROM was optional and this may have influenced this use. This Knowledge Focused strategy is also important when it is considered that being able to use the CD-ROM to learn and understand the subject matter emerged as an important reason in being motivated to use the CD-ROM.

FACTOR II – Self Testing

The five items below loaded on to the second factor (Q23, Q25, Q31, Q37 and Q39):

> *23.I used the Quicktest facility to test how much information I had taken in from the CD-ROM*
> *25.I found the Quicktest facility on the CD-ROM useful*
> *31.I looked at the questions in the Quicktest facility after I completed each topic on the CD-ROM*
> *37.I used the questions in the Quicktest facility for revising*
> *39.I went through all the Quicktest questions for the sections of the CD-ROM I studied*

The factor was identified as the Self Testing strategy and demonstrates that students used the Quick Test facility to evaluate what they had learnt after they had used the CD-ROM and the other course material. However, the questions that make up the strategy refer to different aspects of using the facility. One aspect measured 'when the facility was used' (Q31 and Q39) and another 'for what purpose it was used' (Q23 and Q37). This may indicate that there are separate facets to this strategy that should be further investigated. That is, why the Quick Test facility was examined in the first instance and what was the result of this initial exposure.

FACTOR III – Notetaking

The following four items loaded on to the third factor (Q20, Q21, Q29 and Q33):

> *20. I took hand written notes from the CD-ROM*
> *21. I copied diagrams from the CD-ROM into my own notes*
> *29. I used the CD-ROM to make additional notes to the ones I made from the other course material*
> *33. I printed off diagrams and images from the CD-ROM*

This factor was identified as Notetaking. Based on the items, this strategy reflected that notetaking behaviour is a distinct and important part of using the CD-ROM even though students did not use the Notebook facility and reported making few notes from the CD-ROM as indicated by the low scores for this question (see Table 6.3).

FACTOR IV – Objectives

The five questions below (Q19, Q27, Q32, Q35 and Q38) loaded onto the final fourth factor that emerged from the cognitive set of items:

19. I looked at the objectives before going through each section of the CD-ROM
27. I referred back to the objectives as I worked through each section of the CD-ROM
32. I looked at the objectives after completing each section on the CD-ROM
35. I found the objectives on the CD-ROM useful
38. I was concerned that I understood the information on the CD-ROM

This factor was identified as an Objectives based strategy, since the questions refer mainly to the use of the Objectives facility on the CD-ROM. The questions indicate that this feature used by students as a checklist before going through a particular section to determine what they should have learnt at the end of the section. This behaviour is similar to the Self Testing strategy, and like that strategy there needs to be further investigation of why the Objectives facility was used on the CD-ROM and what impact it had on the students' learning of the domain.

6.4.3. Tool Management strategies

Item Analysis indicated that the inclusion of a number of items in the Tool Management section of the questionnaire needed to be reconsidered. Subsequently, the following items were not included in the factor analysis,Q40, Q47, Q52, Q57, Q60, Q65, Q67 and Q69 (see below).

40. *I did not have enough time to look through all the sections of the CD-ROM*
47. *I preferred the graphics on the CD-ROM to the text or narration*
52. *I did not place a limit on the time I spent using the CD-ROM*
57. *I thought there was too much text on the CD-ROM*

60. *I went through all the layers of information for each of the sections I studied on the CD-ROM*
65. *I turned the volume down before the narration ended*
67. *I would have liked to have spent more time looking at the CD-ROM*
69. *I had a look at what the various tools (i.e. Camera, Album, Ruler) on the CD-ROM did but decided not to use them*

In all cases, the correlations between these rejected items and the total score on this section of the questionnaire were less then 0.25 and in the case of Q40, Q47, Q52, Q57 and Q65 less than 0.17. Speculation about why these items failed to correlate with the other items could be attributed to question design, i.e. the questions were ambiguous or needed clarification, or it may have simply been that the questions were not relevant to the students' study of the CD-ROM.

The model of four factors explained 49% of the variance in the set of items. Three questions failed to produce significant loadings onto any of the four factors (Q44, Q49 and Q53).

44. *I liked the narration on the CD-ROM*
49. *I went through the tutorial before going through the other sections of the CD-ROM*
53. *I found it easy navigating around the CD-ROM*

Again, speculation about why these questions did not load leads to a consideration of question design and to the relevance of these questions to the set of items that did load.

Thus, following the item analysis of the questions from the tool management section of the questionnaire, 25 items were included in the factor analysis but only 22 items successfully loaded on to one of the four factors. Only three of the four factors could be identified as strategies, these were termed: Feature Satisfaction, Tool Use and Window Shopping.

FACTOR I – Feature Satisfaction

The six items below loaded on to Factor I (Q41, Q42, Q56, Q61, Q64 and Q70).

41. I read all the text on the CD-ROM for the sections I studied
42. I found the Map feature useful in helping me navigate around the CD-ROM
56. I liked the graphics on the CD-ROM

61. I could usually find my way back through the information on the CD-ROM to places of interest or importance
64. I liked the text and the text hotspots on the CD-ROM
70. In the sections of the CD-ROM that it occurred, I found it useful having the information organised into 3 layers

The factor was named Feature Satisfaction. A feature was considered to be an element that was common to all sections on the CD-ROM, e.g. text, graphics, the layering of information. In this study, this factor appeared to account for aspects of using the CD-ROM that were assumed in Study II to fall under the separate strategies of Modality Preference and Navigation. Modality Preference referred to the preference for two of the different modes of presenting information on the CD-ROM (i.e. text, graphics, and narration). However, this did not appear to be an appropriate outline of a strategy since the questions that loaded on to this factor reflected opinion about using the CD-ROM and not behaviour.

FACTOR II – Tool Use

The four items below loaded on the second factor (Q48, Q54, Q62 and Q63):

48. I thought it important to use the tools (i.e. Camera, Album, Ruler) on the CD-ROM
54. I had a go with each of the tools on the CD-ROM, before deciding whether or not to use them
62. I did not use the tools on the CD-ROM (i.e. Camera, Album, Ruler) because I thought it would take too long to learn how to use them
63. I found the tools on the CD-ROM (i.e. Camera, Album, Glossary, Ruler) useful

This set of items dealt exclusively with use of the Tools on the CD-ROM, thus the strategy was termed Tool Use. As a strategy this combination of questions tells us little about the management of the CD-ROM. Rather, the questions determine whether the Tools on the CD-ROM were used and questions 48 and 63 offer a subtle distinction in finding the Tools useful. This ambiguity is also evident in relation to the four items that loaded on to Factor III.

FACTOR III – Not identified as strategy

The four items below loaded on to Factor III (Q43, Q45, Q46 and Q51):

> *43. I found the tools on the CD-ROM (i.e. Camera, Album, Ruler) difficult to use*
> *45. I often found myself getting to a screen on the CD-ROM and then wondering how I got there*
> *46. I often found that I became lost in the layers of information on the CD-ROM*
> *51. I had difficulty making the tools on the CD-ROM (i.e. Camera, Album, Ruler) work properly*

These items cover various difficulties encountered whilst using the CD-ROM particularly in navigating the information and using the tools. This factor was seen as representing obstacles that students encountered in their use of the CD-ROM but could not be considered a strategy. That is, the questions represented what happened as a consequence of study or strategic behaviour.

FACTOR IV – Window Shopping

The following eight items loaded on to the fourth and final factor (Q50, Q55, Q58, Q59, Q66, Q68, Q71 and Q72):

> *50. Before going through the various sections I looked through the CD-ROM to see what would be useful*
> *55. I used the reference facility on the CD-ROM*
> *58. I found it easy to look for and find the information I wanted on the CD-ROM*
> *59. Before studying a particular section on the CD-ROM I had a quick look through it to see what it covered*
> *66. I used the Trail facility to see what material I had covered in the section I was studying*
> *68. I used the Map facility to 'jump' to a particular point on the CD-ROM that I wanted to go to*
> *71. I used the glossary facility on the CD-ROM*
> *72. I used the Trail facility to return to parts of the sections I previously covered*

In Study II Window Shopping was identified as a Tool Management strategy, characterised by a cost assessment exercise where components and information on the CD-ROM are initially explored and appraised for usefulness. This influenced which components were used and what information was examined on the CD-ROM. This strategy is reflected in the loading of items on the fourth factor that was also termed

Window Shopping. This factor loads items associated mainly with navigation behaviour, especially the use of navigation aids such as the Trail facility (this allows students to view an outline of screens they have viewed) which would facilitate viewing of specific content on the CD-ROM at the discretion of the student.

6.4.4. Use of strategies

The Factor Analyses revealed a series of strategies and by examining the nature of the questions that loaded on to factors, a picture emerges of each strategy. By calculating the average score of the items that formed a particular strategy, a mean subscale score can be calculated (see Table 6.3 below). This provides an insight into the extent to which the students used each of the strategies.

Table 6.3: Descriptives for Computer-based Learning Strategies

Strategy	Median	Mean	St.Dev
Presentation format	3.27	3.29	0.53
Resource Exploitation	3.29	3.27	0.63
Perceived value of IT	3.03	3.00	0.64
Expectancy	3.07	3.17	0.71
Knowledge Centred	2.77	2.83	0.71
Self Testing	2.76	3.00	1.02
Notetaking	1.25	1.56	0.67
Objectives	2.24	2.20	0.71
Feature satisfaction	3.04	3.17	0.54
Tool use	2.37	2.50	0.47
Window Shopping	2.46	2.50	0.66

Based on the original subscale used for each item, the figures can be interpreted as follows:

1 1.1 1.2 1.3 1.4	1.5 1.6 1.7 1.8 1.9 2 2.1 2.2 2.3 2.4	2.5 2.6 2.7 2.8 2.9 3 3.1 3.2 3.3 3.4	3.5 3.6 3.7 3.8 3.9 4
no to very little incidence of behaviour indicative of that strategy	some incidence of behaviour indicative of that strategy but to a fairly limited extent	moderate incidence of behaviour indicative of that strategy	high incidence of behaviour indicative of that strategy

Using this scale to interpret the mean scores of the sample for the motivational strategies, it is apparent that there was a moderate level of motivation to use the CD-ROM. These levels of motivation reflect the fact that the decision to use the CD-ROM was left to the discretion of students. However, the strategies could apply just as well to a context where students are required to use a CD-ROM or another computer-based learning environment as part of their course.

Designers and educators could assess to what degree students are motivated to use the product because of the way it presents information (Impact of Presentation strategy) as opposed to using it because they feel they need to (Resource strategy). Use of the product could also be explored to see if it is influenced by the IT Potential strategy, that is, believing IT has great potential may lead to greater use of the product as opposed to fear or lack of potential meaning that the product is barely used.

In terms of the Cognitive strategies, the Self Testing and Knowledge Focused strategies were adopted to a greater extent than the other Cognitive strategies. This would indicate that students used the CD-ROM to a moderate extent to understand the information from other source material. They also used the QuickTest facility to test the knowledge they had accumulated over the study of the course.

The Knowledge Focused strategy produced an average score of 2.83, indicating that the CD-ROM was used to a moderate extent for understanding and clarifying information about the domain. The loading of Q36 on to the factor identified as this strategy (see below) also indicates that understanding and clarification is linked to when the CD-ROM is studied in relation to the other course material, particularly afterwards.

> *36. I would look at relevant sections of the CD-ROM after I had studied the course material*

This is an important finding in two respects: firstly, the students were not given any indication of how the CD-ROM should be used in relation to the other course material. Second, if students adopted this behaviour of using CD-ROM after studying the other course material and found this added to their understanding of domain; then use of the CD-ROM in terms of the other course material and its impact on cognitive strategies requires further investigation.

Interestingly, Notetaking, was an activity that failed to occur to any great extent, if at all, when using the CD-ROM. It may be that students did not believe there was a need

to take notes from the CD-ROM since they may have examined the text based material first and made substantial notes from that resource. This is also an activity linked to using the CD-ROM that requires further investigation.

The Tool Management strategies, as discussed in section 6.4.3, remain difficult to interpret and of all of the classes of strategies identified this requires extensive further examination. At best, what could be interpreted from the Tool Management strategies is that students were moderately satisfied with the features and organisation of information on the CD-ROM (Feature Satisfaction strategy). Yet students were likely to encounter a moderate degree of difficulty in navigating the CD-ROM and using the Tools as indicated by the Tool Use strategy that emerged from the analysis. One factor, Factor III, could not be determined to be a strategy rather a description of some of the difficulties that students are faced in the study of the CD-ROM and the implementation of strategic behaviour.

The cost assessment exercise of Window Shopping was also likely to be adopted to a moderate degree. With the exception of the Window Shopping strategy, the strategies in this Tool Management class are unlikely to offer much benefit to educators and designers because of the difficulties linked to their interpretation.

6.4.5. Comparison of strategies

Table 6.4 presents the correlations between each of the strategies.

Table 6.4: Correlations bewteen strategies

	Pres.	Res.	Val.	Exp.	K.Cn	S.Tst	Note	Obj	Feat	Tool
Res.	0.31									
Val.	0.64	0.23								
Exp.	0.51	0.20	0.40							
K.Cn	0.54	0.25	0.51	0.35						
S.Tst	0.27	0.07	0.11	-0.01	0.37					
Note	0.16	0.01	0.12	0.22	0.36	0.22				
Obj	0.38	0.19	0.34	0.30	0.54	0.38	0.47			
Feat	0.42	0.26	0.33	0.25	0.57	0.39	0.20	0.41		
Tool	0.12	-0.06	0.13	0.15	0.22	-0.03	0.21	0.18	0.09	
W.Sh	0.24	-0.04	0.22	0.22	0.42	0.32	0.39	0.48	0.45	0.20

Note: Pres.= Presentation format; Res.= Resource Exploitation; Exp.= Expectancy; Val.= Perceived value of IT; Note= Notetaking; S.Tst= Self Testing; K.Cn= Knowledge Centred; Obj= Objectives; Feat= Feature Satisfaction; Tool= Tool use; Diff= Difficulties; W.Sh= Window Shopping

Generally, strategies in the Motivation and Cognitive classes produced significant positive correlations with each other. In the Motivation class of strategies, Impact of the Presentation Format also correlated positively with the Cognitive strategies. This indicates that greater engagement with the CD-ROM's content was likely to occur if the student used the CD-ROM because they believed the way it presented information was going to be beneficial.

This may seem obvious but has implications for educators and designers who may encounter students who have anxieties about using the technology. These findings would indicate that such students would not engage with the content of the product to any great extent. This was further supported by the correlation between the Knowledge Focused strategy and respectively the motivational strategies of Value of IT and the Expectancy. The correlations between these strategies also indicate that believing that the technology can offer benefits leads to greater engagement with the product.

In the Tool Management set of items few of the strategies correlated significantly with one another. The Window Shopping strategy fared best, amongst others, it correlated significantly with the Knowledge Focused strategy. This indicates that those students

who selected the parts of the CD-ROM they examined were more likely to use the CD-ROM to increase their understanding of the domain.

Table 6.5 presents the Cronbach's Alpha reliability statistic for each of the strategies.

Table 6.5: Reliability statistics for strategies using Cronbach's alpha

Strategy	Alpha
Impact of presentation format	.82
Resource Exploitation	.53
Perceived value of IT	.77
Expectancy	.72
Notetaking	.79
Self Testing	.92
Knowledge Centred	.81
Objectives	.77
Feature Satisfaction	.73
Tool use	-.06
Window Shopping	.80

A figure of .7 or above is generally regarded as indicating that the set of items tested, in this case for each strategy, has a good measure of internal reliability (Kline,1993). These analyses indicated that most of the scales had 'sufficient' to 'very good' internal reliability. To clarify what this indicates: if the items in a subscale measured the same construct, each student would be expected to be consistent in their responses to the items. The findings suggest that this was the case for most of the strategies. Two strategies, or sets of items, were identified as unreliable, the first of these were the set of Resource Management items that produced an Alpha of .53 and the Tool Management set of items that produced an Alpha of -.06. The low Alpha's for these two strategies raise further doubts about whether it is possible to draw conclusions about the strategies students used from their responses to the questions to the Tool Management part of the questionnaire.

6.5. Summary

The study that is reported in this chapter examined the learning strategies of students using a questionnaire developed from the findings of interviews carried out in an earlier study, Study II (reported in Chapter 5). A series of strategies emerged in relation to using the CD-ROM. These practices covered distinct aspects of motivation, cognition and management of the resource. The strategies in the Motivation and Cognition classes emerged more clearly than those in the Tool Management class.

The questionnaire that was designed and tested in the study, comprised three main strategy sections: motivation, cognition and resource management. Few questions were rejected from these sections following both item and factor analysis. From the motivation section four strategies emerged, these indicated that use of the CD-ROM was prompted by a series of factors. These included, a desire to use all available course materials (Resource Exploitation strategy); a belief in the learning potential of IT (Perceived Value of IT strategy); a set of expectations about the potential of the CD-ROM (Expectancy strategy); and an attraction to the way the CD-ROM presented information about the domain in question (Impact of the Presentation Format strategy).

Factor analysis of the Cognitive strategy questions also revealed four factors. The first of these indicated that the CD-ROM was used to increase students' understanding of the domain and to also to add clarification to concepts from the other course material (Knowledge Focused strategy). A strategy linked to taking notes was also identified (Notetaking strategy) although the responses of students indicated that very little notetaking occurred from the CD-ROM. Two other cognitive strategies that emerged included Self Testing, referring to the use of the QuickTest facility. A final Objectives strategy referred to the use of the Objectives as an indicator of what needed to be learnt about the domain from the CD-ROM.

The Tool Management section of the questionnaire offered less definite notions of strategic behaviour. Although four factors emerged only three could be identified as referring to strategic behaviour and even then the extent to which they appear relevant to the learning context is questionable. The strategies identified in relation to this class of behaviour included: Feature Satisfaction, referring to opinion students had about features of the CD-ROM including text and graphics; Tool Use referring to the extent to which the various tools were used; and Window Shopping referring to the selective way in which information was examined.

The use of the questionnaire is limited in the amount of detail it can provide and information is required about the strategies that emerged, particularly in the case of the Tool Management strategies. In order to provide further information about strategic behaviour, the study reported in the next chapter, the final in the research programme, details the findings from a series of interviews conducted with twenty students.

Chapter 7

STUDY IV: A DETAILED EXAMINATION OF STUDENTS' COMPUTER-BASED LEARNING STRATEGIES USING INTERVIEWING.

7.1. Introduction

This chapter reports on the fourth and final study of the research studies. The aim of the study was to further investigate and build on the findings of Study II and III. In Study II, eight students were interviewed about their behaviour and learning processes when using the Human Brain CD-ROM. The findings from this study led to the formulation of a tentative framework of learning strategies. This framework proposed three main classes of strategy: Motivation, Cognitive and Tool Management. The framework informed the design of a computer-based learning strategies questionnaire in Study III. The purpose of that study was to clarify the nature of the strategies that comprised each class and to examine the reliability of those strategies. The findings from Study III indicated that the Motivation and Cognitive strategies were sound and reliable representations of behaviour that occurred when using the CD-ROM. However, it was difficult to determine the nature of the Tool Management based strategies. One factor was unidentifiable as a strategy and most of the remaining factors/strategies loaded a range of questions that most often reflected not so much what students did as what they thought about certain aspects of the CD-ROM. The cause of this difficulty appeared to be errors made in the inclusion and phrasing of questions in the Tool Management section of the questionnaire.

Thus, the study reported here sought to further investigate the Motivation and Cognitive strategies and clarify the nature of the Tool Management strategies. The chapter reports on twenty in-depth interviews that were carried out with students who used the CD-ROM. The students were interviewed on completion of the course they were studying, where the CD-ROM was an optional part of the course material. Students also used the CD-ROM during the interview to support or explore issues raised in their account of using the technology. The findings of the interviews aimed to extend the understanding

of the strategies in the framework and offer further explanation for the computer-based study practices of students.

The following sections of this chapter provide details of the subjects' interviews, the interview schedule, and the analysis and findings of the interviews.

7.2. Method

7.2.1. Interview Schedule

The interview schedule adopted in this study was similar to that used in Study II. The schedule was designed to provide an account of each student's experience of using the CD-ROM and to a lesser extent their experience of studying the course and their general computing behaviour. The questions, however, did not ask students specifically for details of their learning strategies. Rather, it was intended that these processes and behaviours would be determined in the analysis of the accounts provided by students about their use of the CD-ROM. The interview consisted of five main parts, each of which examined particular aspects of the students' learning experience with the CD-ROM (see Table 7.1.).

Table 7.1: Interview schedule showing parts, aspects and strategy indicators.

Parts	Aspects	Strategy Class
General experience of the course	• What they thought about the course.	N/A
	• Previous experience of studying OU courses	N/A
	• Nature of degree	N/A
	• Use of course material	Motivation
General computing experience	• Computing experience	Motivation
	• General Usage	Motivation
General experience of using the CD-ROM	• Time spent using the CD-ROM	All
	• Use of Instruction Section *	Tool
	• Sections used and favourite section(s)*	Mot/Cog
	• When the CD-ROM was used in comparison to the other course material	Mot/Cog
	• How the CD-ROM was used with the other course material	Tool
	• Navigating around the CD-ROM*	
Features of the CD-ROM	• Graphics*	Cognitive/Tool
	• Text*	Cognitive/Tool
	• Narration*	Cognitive/Tool
	• Quick Test*	Cognitive/Tool
	• Objectives*	Cognitive/Tool
	• Organisation of information*	Cognitive/Tool
Tools on the CD-ROM	• Glossary*	Tool
	• Camera/Album*	Tool
	• Notepad*	Tool
Other aspects of CD-ROM use	• Note-taking	Cognitive
	• Printing	Tool/Cognitive
	• Problems encountered*	Tool

In Study II the interviews with students were conducted without the CD-ROM being used during the interview. In this study, with the exception of the fourth student interviewed (S4), all students were interviewed with the CD-ROM being used at some point during the interview. In Table 7.1, (*) indicates what aspects of the interview involved the use of the CD-ROM. In the case of those students who were interviewed over the telephone, it was pre-arranged that when the interview took place they would be interviewed using the telephone and sitting in front of their own computer. These students were asked to report or confirm any activity they performed on the CD-ROM when they used it. On the other end of the telephone the interviewer sat with a computer, mirroring the student's actions.

In using the computer, students would be directed to a particular point of the CD-ROM and asked to perform or talk through an activity depending on the aspect of the interview being covered. In most cases, use of the CD-ROM during the interview took place on the students' own computer. In some cases, where the students were interviewed face-to-face, a colour PC laptop, with the CD-ROM installed, was used (S1, S2, S7, S10, S11 and S12). Any activity performed with the computer during the interview was not itself regarded as a measure or indicator of strategic behaviour but the use of the CD-ROM during the interview served an important purpose. By allowing students to use the CD-ROM during the interview, the interviewer could observe the accuracy of their account. On the part of the student, the use of the CD-ROM during the interview was also intended to stimulate their recall and allow them to demonstrate instances of behaviour that would support their accounts.

7.2.2. Participants

The SPOTLITE questionnaire contained a general section about using the CD-ROM that also asked students if they would agree to be contacted with a view to arranging an

interview about their use of the CD-ROM. In Study III, the questionnaire was sent to 500 students studying Biology, Brain and Behaviour, and was returned by 240 students. From that sample, 140 indicated that they were using the Human Brain CD-ROM produced for the course and 62 agreed to be contacted with a view to arranging an interview. In total twenty students who used the CD-ROM were interviewed; four were male and sixteen were female with a mean age of 41.85 years (SD=9.93). Table 7.2 provides details of the students who agreed to be interviewed.

Table 7.2: Details of interviewees

S	Gender	Age	Interview Method
1	F	51	Face-to-face
2	F	32	Face-to-face
3	F	53	Face-to-face
4	F	28	Face-to-face
5	F	43	Face-to-face
6	M	32	Face-to-face
7	F	45	Face-to-face
8	F	53	Face-to-face
9	F	49	Face-to-face
10	F	40	Face-to-face
11	F	49	Face-to-face
12	F	36	Face-to-face
13	M	54	Telephone
14	F	40	Telephone
15	F	23	Face-to-face
16	F	47	Telephone
17	F	35	Telephone
18	F	59	Face-to-face
19	M	39	Face-to-face
20	M	36	Telephone

The following sections of this chapter present the findings from the interviews conducted with the twenty students along with the data they provided in the SPOTLITE questionnaire. These findings are the result of analysing the reports of the twenty students in two phases: initially by categorising parts of the interview into possible strategy indicators using NUD*IST v4. Then a more detailed analysis of each of these groupings aimed to identify specific strategies and any possible components by the extraction of behavioural activities or study practices that appeared to be common amongst students in their reported use of the CD-ROM.

The first sections, 'general findings', frames the evidence for learning strategies with information about studying the course in general, computing background and their general use of the CD-ROM. The discussion of learning strategies in the following sections, Motivational, Cognitive and Tool Management strategies, discusses the evidence provided in the interviews for the existence of these strategies.

7.3 General findings

This section concentrates on the learning strategy findings that emerged from the interviews carried out with the twenty students. The reports of students were analysed in two stages. Initially, the segments of the interview were categorised into possible strategy indicators using NUD*IST v4. This procedure was followed by a more detailed analysis of the dialogue in each of the categories with the aim of identifying specific strategies. A strategy constituted - common behavioural activities or study practices that were reported by students in their use of the CD-ROM.

The section begins by detailing information about the students' general study of the course, their computing background and their general use of the CD-ROM. This information emerged from both the interviews and the responses of the twenty students to the SPOTLITE questionnaire in Study III. This information provides a context against which to compare the students' learning strategies in using the CD-ROM. The remainder of the chapter presents the strategies identified from the interviews in terms of the three general classes of strategies identified in earlier studies: Motivation, Cognitive and Tool Management. The scores of students on the SPOTLITE inventory in Study III frame the evidence presented for each learning strategy.

7.3.1. Studying Biology, Brain and Behaviour

Generally, most of the twenty student interviewed about using the CD-ROM reported that they enjoyed studying the course but found it difficult. Most students studying the course have often studied a series of natural science courses with a leaning towards Biology or social sciences courses in Psychology. Many of the students, from both natural and social science faculties, reported not being used to studying the type of information that comprised parts of the course. For example, S2, S7, S14, S18 were studying the course as part of a psychology course and they reported finding the biology

aspect of the course difficult to embrace. By contrast, S12, S15 and S19 were biology students who found the psychology aspect of the course difficult. Apart from the nature of the course content, many students reported finding the amount of information to be learnt overwhelming. S10 failed to complete the course, choosing to drop the course two-thirds of the way into it. Interviewee S4 was the only student to study another OU course alongside Biology, Brain and Behaviour. This course was in artificial intelligence and she reported that the two complemented one another.

Most of the twenty students chose to study the course because it was a requirement of their chosen final degree, with a few studying the course because of a general interest in the subject matter or career aspirations (see Table 7.3). This latter group of students were also less likely to be studying towards a particular degree; rather they studied a series of courses from a number of disciplines to a gain a general OU degree. For three of the students interviewed (S6, S12 and S13) Biology, Brain and Behaviour was the first course they had studied since completing an OU foundation course, a precursor to studying degree level courses. The rest of the group had studied between two and six courses with the OU prior to registering on Biology, Brain and Behaviour.

Table 7.3: Degree path of students and motivation for studying Biology, Brain and Behaviour

S	Degree Path	Reason for study
1	General	Interest
2	Psychology	Degree profile
3	Psychology	Degree profile
4	Psychology	Degree profile
5	Natural Sciences	Interest
6	Social Sciences	Career aspirations
7	Social Sciences	Degree profile
8	Biology	Interest
9	Biology	Career aspiration
10	Social Sciences	Interest/Career
11	Psychology	Degree profile
12	Biology	Interest
13	Biology	Degree profile
14	Psychology	Degree profile
15	Biology	Degree profile
16	Biology	Degree profile
17	Psychology	Degree profile
18	General	Interest
19	Biology	Degree profile
20	Biology	Degree profile

7.3.2. General Computer Use

In the SPOTLITE questionnaire, all the students interviewed reported using a computer prior to using the CD-ROM. For most of the students using a computer was an activity that occurred solely at home, although some did use a computer at both home and work (see Table 7.4). Weekly computer use varied amongst students, with some using it daily and others using it maybe once or twice in a week. With the exception of students S12 and S13, this was the first experience the majority had of using a CD-ROM in their study of OU course material. Most students used the CD-ROM at home, S11 used it at a friend's house, whilst S20 was able to use the CD-ROM at home and at their place of work.

In the SPOTLITE questionnaire, all the students reported using a computer for 'general applications' use (e.g. word-processing and spreadsheets), with a number also using the machine for Internet and email activities (see Table 7.5). This was confirmed in the subsequent interviews with students, with many reporting that word-processing was the main task for which they used a computer. In the interview students were also asked to estimate the amount of years experience they had with computers with most reporting between 5 and 10 years. In the case of some students, computing experience and expertise impacted on their motivation to use the CD-ROM; this is discussed in terms of the findings for the motivation class of strategies presented later on in this section.

Table 7.4: General Computer Use

Student	Where did they generally use a computer	Weekly computer use	Previous experience with a CD-ROM	Where did they use the CD-ROM
1	Home & Work	Varied	Yes	At home
2	Home & Work	Less than daily	Yes	At home
3	At home	Varied	Yes	At home
4	At home	Varied	Yes	At home
5	At home	Varied	Yes	At home
6	Home & Work	Daily basis	Yes	At home
7	At home	Daily basis	Yes	At home
8	At home	Less than daily	Yes	At home
9	Home & Work	Daily basis	Yes	At home
10	Home & Work	Varied	Yes	At home
11	Home & Work	Daily basis	Yes	Friend's home
12	At home	Less than daily	No	At home
13	At home	Daily basis	No	At home
14	At home	Less than daily	Yes	At home
15	Home & Work	Daily basis	Yes	At home
16	Home & Work	Daily basis	Yes	At home
17	At home	Less than daily	Yes	At home
18	At home	Daily basis	Yes	At home
19	At home	Varied	Yes	At home
20	Home & Work	Daily basis	Yes	At home & work

Table 7.5:Computer experience

S	General*	Email	Internet	Games.	Experience YRS
1	✓	✓	✓	✓	15
2	✓				2
3	✓	✓	✓		3
4	✓			✓	3
5	✓	✓	✓		-
6	✓	✓	✓	✓	10
7	✓	✓	✓		6
8	✓				2
9	✓	✓	✓	✓	10
10	✓				10
11	✓				-
12	✓		✓		14
13	✓	✓	✓	✓	11
14	✓	✓	✓	✓	7
15	✓	✓	✓	✓	5
16	✓			✓	3
17	✓			✓	3
18	✓	✓	✓		15
19	✓	✓			3
20	✓	✓	✓	✓	2

*Word-processing and spreadsheets

7.3.3. General use of the CD-ROM

Almost half the sample used all the sections on the CD-ROM (S5, S7, S8, S10, S13, S14, S17, S19 and S20) (see Table 7.6). Students S2, S3, S4 and S11 were unable to run the Hands on Brain section of the CD-ROM but examined all the other sections. Interviewee S1 reported not studying the Speech, Hearing or Vision sections on the CD-ROM. She decided to leave these sections out of her general study of the course for reasons of time and difficulty. This reason was also given by S6 and S15 in terms of not studying the Vision section of the CD-ROM. S12 examined only two sections on the CD-ROM, the Overview and the Spinal Cord. Along with a lack of time, she expressed a disappointment with these sections leading her not to examine the CD-ROM any further. The section that students found the most useful was the Cerebral Cortex.

Students provided an estimate of the time spent using the CD-ROM in the SPOTLITE questionnaire some three months prior to the interviews being conducted. The total amount of time spent using the CD-ROM was addressed in the interviews and most students were able to provide an approximate total figure but for those unable to do so Table 7.6 provides the figure reported in the questionnaire. The estimations provided in the interviews and the questionnaire seemed, where comparison was possible, to coincide. The estimates taken from the questionnaire are indicated by the (*) symbol in Table 7.6. What is evident is a fair degree of variation in terms of the time spent using the CD-ROM, with times ranging from 1.5 hours to possibly 30 hours. Eight students (S1, S3, S4, S11, S14, S15, S17 and S19) reported using the CD-ROM for 10 or more hours. These estimations of time, often calculated by summing the amount and duration of sessions spent using the CD-ROM, are further discussed in terms of the Usage strategy in the Tool Management class of strategies. With the exception of S11, all the students used the CD-ROM on an individual basis. Interviewee S11 was the member of

an informal study group who met monthly and in that context used the CD-ROM for an additional three hours.

Table 7.6: Sections used and time spent on CD-ROM

S	Overvi	HoB	CC	Scord	Speech	Hearin	Vision	Approx. Time (hrs)
1					×	×	×	20
2		×						5*
3	✓	×						10
4		×					✓	20*
5	✓	✓	✓					2*
6			✓	✓	×		×	7*
7	✓	✓						1.5
8		✓	✓	✓				3*
9	✓		✓	✓	×	×	✓	3-4
10		✓						2-3
11		×	✓					20
12		×	×		×	×	×	2
13	✓	✓	✓	✓				8
14		✓			✓	✓	✓	12
15				✓	×	✓	×	10
16			✓	×	×			2
17			✓		✓	✓	✓	10
18	✓	×	✓	✓				3-4
19		✓	✓					20-30
20		✓	✓					8*

section examined
✓ particularly useful section
× not examined
* estimate of time taken from questionnaire as information unavailable from interview

7.4. Motivational strategies

7.4.1. Resource exploitation

The findings of this strategy relate to a much wider issue of studying the course and the use of course materials. From the interviews it emerged that almost half the sample of students used the CD-ROM because it was part of the course material (S2, S3, S5, S8, S9, S10, S11, S12, S13, S14, S17 and S18, see example excerpts below). These students were also likely to gain scores of between 3 and 4 for the same strategy on the SPOTLITE questionnaire. Other students reported being more selective about the course materials they used, particularly in terms of the video and audiocassettes provided to students. The main reason for this was a lack of "time to do everything" as most of the remaining students reported.

> *INTERVIEWER: You should have received the CD-ROM a few weeks into the course. You should have known that a CD-ROM was available. So, casting your mind back to the beginning of the course, can you remember what your initial thoughts were about using the CD-ROM?*
> *S17: I would have got it out of interest because you immediately think 'if you don't use it are you missing out' and as much as they said 'you don't need to use it[the CD-ROM] and the all the information is else where' I would feel that if I hadn't actually used it and put it on then 'was I missing out'.*

7.4.2. Expectancy

In the interviews students were asked to recall what their initial thoughts were about using the CD-ROM before they started using it. From this area of questioning there emerged a set of expectations about using the CD-ROM that, in part, prompted the students to start using the CD-ROM.

Only two students, S15 and S17, reported that they had no real expectations about what the learning experience with the CD-ROM would be like. However, the majority of students reported that they expected the CD-ROM to clarify concepts and to add to their understanding of concepts in the other course material. A number of students specified that they expected the imagery on the CD-ROM to clarify the positioning and nature of

the anatomical structures of the brain (S1, S3, S4, S6, S12, S18, S20). The excerpts below from the interviews with students S1 and S5 are typical of the expectations reported by students:

> *INTERVIEWER: Can you tell what you initially expected to gain from the CD-ROM?*
> *S1: Something visual...something moving...I mean a moving image which I could much more easily understand the lay out of the brain and something that would stimulate my ability to learn the different bits of the course...in this particular aspect which was about how the brain was formed and where the bits worked and what each did...I didn't get so much what each bit but I did begin to understand the structure better*
> *INTERVIEWER: Do you think it actually achieved those expectations?*
> *S1: I think more so than any other medium that I tried...I did actually have a go at watching the video that was about the structure of the brain but I didn't watch it for very long...I found it much more easy to use the CD-ROM because it was interactive, because I had to do things to get my attention...it was a much better use of my time I felt*
>
> .
>
> *INTERVIEWER: Can you tell me what you expected to gain from the CD ROM?*
> *S5: I think it gives another dimension on things and I was hoping for another approach to learning for the course and hopefully an easier way to learning.*
> *INTERVIEWER: You talk about the different approach. How do you characterise the current approach and what kind of approach were you looking for?*
> *S5: Well I mean there is the standard book work and then of course the videos and audio tapes, um and the CD ROM gives you the opportunity of some interaction material so it perhaps gets you thinking in a different way, another dimension...the 3D models on the CD ROM and being able to manipulate with the Hands on Brain, it sort of gives you that extra dimension and one of the other students commented to me about the video tapes, the one on the brain, it was guaranteed to send us to sleep and it is quite heavy going, you know. I think that the CD ROM does give you that added dimension to keep you interested.*

Above, S5 talked about interacting with the material on the CD-ROM a feature that other students expected of the CD-ROM. However, some students, S4, S10, S12 and S13, had specific ideas about the level and nature of interaction they expected the CD-ROM to deliver. These students were not only disappointed by what they reported as a lack of interaction but also indicated that this had a negative impact on their use of the CD-ROM as indicated in the excerpt from S10 below:

> *INTERVIEWER: What were the things you expected to gain from using the CD-ROM?*
> *S10: I suppose I expected to gain more control over how I could learn, in that, for example if there was a nice big brain there I could zoom round it in a little spaceship, I could poke bits and see what happened and pull bits out and see what they were attached to and then whiz round the back and push a button and it would tell me what that joins up to and what the chemicals are and maybe I could follow it through and think where does that chemical go and ask questions that I would like to ask an expert, I suppose, if I had a brain expert in my home for a couple hours and ask all the dumb questions that you would come across when you pulled it apart.*
> *INTERVIEWER: Did it meet those expectations do you think?*
> *S10: No, that may have been my incompetence on the machine and the fact that I didn't have it for very long but I started using and I thought 'well this is all in the book, this is the same layout as the book' to me it was just slower than looking up a picture in a book. It didn't take me where maybe where I wanted to go with it. If it did I certainly didn't work out how to get there.*

INTERVIEWER: One of the things you said before was that you felt the CD-ROM repeated what was in the books. Can you tell what you mean by that?
S10: Well, it had diagrams of the brain and well I thought 'that's in the book'. I can understand that you need that to begin then it would just say 'highlight this and learn more' so you would highlighted it and think 'well, that's in the book as well' so I would have already read that in the books so I wonder why that's on the computer really. In the [videos supplied as part of the course materials] you can pull it out and twist it around and go underneath it from the top and look it from all angles and that would have been more what I was thinking of. The whole three-dimensions.
INTERVIEWER: So how did you feel about the fact that there was this repetition?
S10: I felt very inadequate on the machine to be honest, I thought it must be and I think there must be way to get into this and as you know with the OU there is a lot of work and not a lot of time and I thought I don't how much time to spend trying to get my head round this technology at this stage. Because I think also it came in the course, the timing was really strange, around about Summer School time and the project was coming up and it was like 'I'm not sure if I have time to really invest in working my way through this when so far it's been repeats of what I have got in the books which I am only just about getting my head round anyway' so it was starting to be more confusing.

Above we can see the different kinds of expectation students had but can they be considered motivational behaviour rather than general beliefs about what the CD-ROM would provide? The answer to this question lies in the fact some students reported being disappointed with the CD-ROM when they found that their expectations were not realised. This disappointment had an impact on the students' use of the CD-ROM, as reported by S10 (see above excerpt), S4 and S13, although further investigation is needed concerning the relationship between expectancy and use.

7.4.4. Presentation Format

The strategy Expectancy, and to a greater extent Resource Management, reveal why students started using the CD-ROM in the first place. This section identifies why students continued to use the CD-ROM once they had started. For the majority of students the answer was the appeal of the way in which information was presented on the CD-ROM, its format. There were a number of ways in which the format appealed to students.

For some students it presented an easier way of understanding the domain, as mentioned by S1 (see excerpt below), S3, S8 and S9. For a number of students it was the fact that the format was interactive, reported by S1, S8, S13, S14 S15 and S19. Below S14 offers

an explanation of what this interactive quality was and the engagement that it allowed. Most students reported that the CD-ROM offered something different than the other course material, as mentioned by S2, S5, S6, S7, S12, S13 and S14. How the format of the CD-ROM was different from the other course material is described by S6 in the excerpt from their interview below. Some students also mentioned that one advantage of the CD-ROM was its convenience as a learning tool, as reported by S7, S8, S9, S13, S18 (see excerpt below) and S20. That is, it could be accessed at any time or that using a computer was often more convenient than say watching a video or listen to audiocassettes in a family setting. In most cases what students were referring to was an advantage of the medium, specifically of the components used to present information, compare to traditional modes of text-based course materials, videos and audio cassettes.

INTERVIEWER: The CD-ROM was an optional part of the course material, can you tell me why you decided to use it?
S1: Because I would rather use it than read the book...I had a go at the book and thought this was really dense I'm going to have trouble with this and there must be an easier way to do this because I said I wasn't very keen on ploughing through all this factual stuff and I couldn't get it to lodge in my brain so I thought maybe a different medium might help and it did. So its really not as an adjunct to the book but ideally in preference to the book...I can only really compare it with the book because as I said every time I watched the video I would fall asleep which is more a reflection on how was I rather than the video...I found it much easier that the book because it moves, because...it is just simpler to see...much clearer much bigger everything about it makes it easier to understand...this gets me more involved it's much more hands on, I felt I was doing something actively to promote my own learning rather than just sitting trying to memorise something which is otherwise what you are trying to do

S6: [The CD-ROM is] just totally different, it's being able to see things in three-dimension which I like because the idea of learning about the brain anyway is quite abstract, everything is in black and white illustrations. I was looking forward to the three dimensional aspect of it and I suppose, and it's true to an extent, you get less text on something like this and what text you do get is going to be more to the point than chapters and chapters in books. It is handy being able to go down the levels but it's more to the point than the books in a lot of cases

INTERVIEWER: Can you tell me why you decided to study the CD-ROM prior to it arriving?
S14: Just because I use a computer and it was another media to have a go at. I must admit that I always forget to record the programmes that come on and the videos I just fell asleep in front of. So, because it's [the CD-ROM] is a hands on tool and you can swap and change and get in and out of different bits it is a lot better than sitting in front of a video with a voice just droning on, you're just going to fall asleep.
INTERVIEWER: How do you think they compared to the graphics in the book?
S14: I liked them because you could click on them and find out more about that particular thing, although some of the graphics are in the book, I do like fiddling around with the mouse and doing different things.

INTERVIEWER: So what were your initial thoughts about using the CD-ROM?

S18: Well, I'm quite happy using computers. The thing about a CD-ROM and a degree television programmes but more a CD-ROM is that you can dodge about in it and you can turn it off and you can think about it and you can go or you can just put it on after you have learnt a little bit on the course which is why I used it. I mean there's a Contents bit, so I looked up and had a go through the initial, the first bit that does a kind of overview. At first, I found it [the CD-ROM] a bit daunting. It was a bit too much to take in and I think I made the mistake that most people do, you put it on and you start getting fascinated and you watch a lot and you think 'I can't learn all this' but then you learnt to break it down and use it in bits and pieces

7.5. Cognitive strategies

7.5.1. Notetaking

In terms of traditional teaching methods notetaking is considered an encoding device, facilitating the storage and future recall of information (Beecher, 1988). In the interviews all the students were asked whether they made any notes from the CD-ROM or printed off any of the figures or diagrams from the sections of the CD-ROM.

Only six of the twenty students reported making notes from the content of the CD-ROM (S1, S2, S11, S15, S17, S19 and S20). For most of the students the notes they made were often brief and used to complement notes they made from the other course material and in all cases the notes were handwritten. On the other hand, S1 reported using the CD-ROM as the basis of her study of the Central Nervous System. However, she reported that the notes she made were of little use when she came to revise them because she did not include any diagrams or figures and so lacked the context that these provided to the information on the CD-ROM. Another student, S10 also reported making notes whilst using the CD-ROM but these concerned the workings of the CD-ROM and not its content. This was the only student to report making notes about the workings of the CD-ROM. She reported making such notes because she was inexperienced in using computers and believed she needed them to use the CD-ROM.

A number of students reported that they did not make any notes whilst using the CD-ROM (e.g. S3, S6, S7, S8, S9, S12 and S14). These students often reported that they made detailed notes from the other course material and because of this practice did not believe it necessary to record information from their sessions with the CD-ROM. Two students, S4 and S16, reported that they made no notes from the CD-ROM because they made no notes from the other course material either. Both students reported that notetaking was not an effective study practice for them.

7.5.2. Self Testing

This strategy emerged from the reports of students that indicated that the QuickTest facility, and to a lesser extent the Objectives facility, were used to check what students had learnt about the domain both from the CD-ROM and the other course material. The QuickTest provides a series of multiple choice questions for each of the sections on the CD-ROM except the Hands on Brain section and the How to use the system section. This facility can be accessed any time the student uses a particular section and is intended to allow the students to test their knowledge of a particular section. The Objectives facility on the CD-ROM allows students to examine the learning objectives that they are expected to have achieved after completing a section on the CD-ROM. Objectives are available for all the sections except the How to use the system section and the Hands on Brain section.

From the interviews it emerged that there were four components related to using these facilities. These included; (i) when the facilities were used; (ii) why they were used; and in the case of the QuickTest facility, (iii) what knowledge the items were used to test and, finally, (iv) what the students did with the feedback the system provided. These could be considered sub-strategies because, as discussed in the remainder of this section, they each embody a variety of behavioural outcomes. However, when the common outcomes are examined, collectively they represent the extent of self-testing behaviour.

The first of the sub-strategies, identified as 'Use', related to when the facility was used. The Objectives facility was often used before starting a section (as reported by S8, S9, S11, S17, S17, S19 and S20) with some students reporting that this mirrored their use of the objectives in the books. However, most students indicated that they used the QuickTest facility after they completed each section of the CD-ROM (S2, S3, S4, S6,

S9, S10, S19 and S20). This use of the QuickTest facility mirrors the way questions are used in the text based course material. In the course texts a chapter typically starts with a series of learning objectives and ends with a series of questions. Other students used the QuickTest facility only at the end of the course when they were revising (S1, S5, S14 and S18). However, it also emerged that some students used the facility after completing each section and then later on in the course for revision (S8, S11, S15, S16 and S17).

A second substrategy that emerged in relation to this strategy referred to why the QuickTest and Objectives facilities were used in the first place. The main response was that they were used as a checklist of information prior to and after the learning experience with the CD-ROM. The Objectives facility was reported by students to help determine what information they should have learnt having gone through the subject area dealt with by the section (S3, S10, S15, S16 and S19). In the case of the QuickTest facility, however, the feedback the system provided helped students to determine where their weakness lay in their understanding or knowledge of the domain and what they had actually learnt. These motives for using the facilities are illustrated in the excerpts below from the interviews with S8 and S11 about their use of the QuickTest facility and S15 whose account was typical of the relationship students indicated between the two facilities:

> *Interviewer: When did you actually use them [referring to questions on the QuickTest facility]?*
>
> *S8: I just used them every time I did it [the CD-ROM] because it helped me to know whether I really took in what I'd looked at. I found that good.*
>
> *S11: ...I found that the QuickTest really showed whether it had gone in or it hadn't. I was also conscious that they're never going to ask us all this stuff, it's impossible. So, it was as much that that I enjoyed doing it than thinking I might get a question on this particular nerve or something....it was a learning tool as well.*
>
> *INTERVIEW: Did you look at the objectives on the CD-ROM at all?*
> *S15: Yes, I did.*
> *INTERVIEW: When did you look at the objectives, was it before you started a section, after or as you were going through the section?*

S15: I think it was a mixture of all of them really. I wouldn't say specifically before I started a section, that's the least likely. It was interesting to look at it after to see what I should have got and compare it to what i did get. They were also useful for revision, it gave me an idea of what direction I should be going in.
INTERVIEW: You talked about the QuickTest being this kind of checklist of what you picked up from the sections, do you think you were using the Objectives in a similar way?
S15: In a very similar way certainly.

In the section of the interview that concentrated on the use of the QuickTest facility, students were also asked about the knowledge they were testing. That is, was it purely what they learnt from the CD-ROM or from a combination of the course materials including the CD-ROM. A few interviewees, S4, S6 and S16, reported that they used the system to test only what they had learnt from the CD-ROM. However, a large proportion reported using the facility to test what they had learnt from both the text and the CD-ROM (S2, S3, S5, S8, S9, S10, S11, S13, S17, S19 and S20). Interestingly, the students reported that the Objectives on the CD-ROM were used in relation to the information purely on the CD-ROM.

Another important finding from the interviews related to what happened with the feedback the students received from the QuickTest facility when they answered a question incorrectly. The facility enables the user to keep answering a question until they provide a correct answer. This opportunity was exploited by a number of users (S1, S2, S3, S8, S11 and S16) who used the system to give them the right answer and then, they reported, often thought through why this was the right answer and/or why their selection had been incorrect. Others reported going back through the information on the CD-ROM or referring back to the books (S5, S10, S13, S14, S19 and S20). Two students, S6 and S17, also reported going through until the correct response was revealed to them but not actively trying to figure out why that was the correct response or trying to reference back to information on the CD-ROM or the text.

Figure 7.1 (below) shows the substrategies and behaviours that comprise the Self Testing Strategy and use of the QuickTest and Objective facilities on the CD-ROM

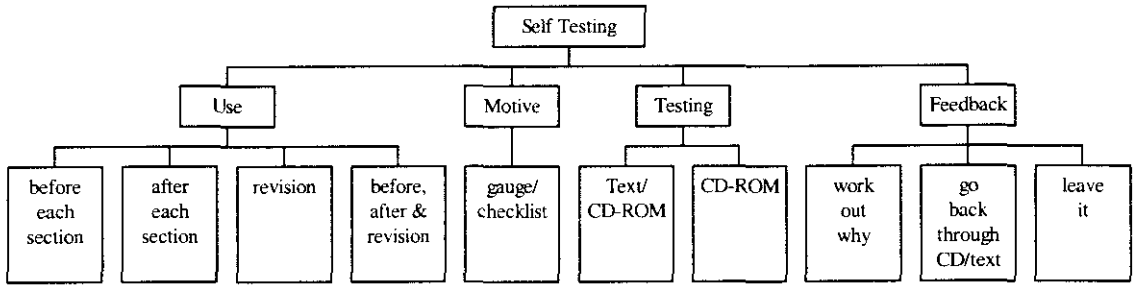


Figure 7.1: The Self Testing strategy

7.5.3. Knowledge focused

This is potentially the most important strategy in the framework for both educators and designers. It provides insight into what the students did with the information on the CD-ROM, specifically the learning purpose of the CD-ROM for the students.

One student, S1, reported that the CD-ROM was her primary source of information when it came to learning about the Central Nervous System on the course. For this student time constraints and personal workload meant that she omitted studying this component of the course from the books.

A common theme throughout the interviews was that the visual imagery was clearer on the CD-ROM and this helped students to understand more fully the structure and architecture of the brain compared to the other course material. The imagery was often reported to provide an added dimension of reality that did not exist in the text based course materials. Interviewees, S1, S2, S6 S14, S15, S16 and S19 reported that the CD-ROM also presented the information they wanted more concisely than the books. The experiences of S15 and S19 are given below; these are typical of the comments of students:

> *INTERVIEW: How do you think, the quantity and the quality of information compared between the books [text based course material] and the CD-ROM?*
> *S15: Heck of a lot more information in the text books. That just goes without saying. But I think the CD-ROM narrowed it down to the more salient points of the sections that it covers. So it gives you a good overview of all those sections. I think it covered the bits you needed to know quite well.*
> *INTERVIEW: How did they help with the understanding of the subject?*

S15: It gives you an idea of where things are in relation to other things, I think that is, again, because of the 3D context of the pictures.

INTERVIEWER: How did they [the images] help in understanding the information?
S19: A lot. Again because of the colour and the detail that has gone into the graphics has made it a lot easier than just looking at a black and white line drawing. Because it has different colours and because you can see the depth of it and all the rest of it that's what I liked about it.
INTERVIEWER: How do you think the images compared to the images on the videotapes and the course texts?
S19: I still say they were better on the CD-ROM because on the video because you are watching it on the TV you don't sit right next to it you sit further back and it's not as clear as it is on here [the CD-ROM], it's very clear.

For S6, S8, S14 and S18 the CD-ROM also helped to reinforce information they had learnt in the other text materials. Interviewee S4 who commented positively on how the CD-ROM helped comprehend the material to be learnt also reported that at the time of using the CD-ROM there was some anxiety about how useful it was to learn information from the CD-ROM, see the excerpt below:

S4: there were bits that you'd go 'oh yes I remember reading something about that in the book' and some of them were, sort of had a different angle and a different slant and it gave you, instead of having a flat picture it gave you a more sort of dimensional shape or concept or whatever. The books took this angle and the Hearing in the CD ROM came at it from another angle, but then in a way that was confusing because you are going, 'well if I learn this which may help me is it going to be examinable in the exam' because it's on a separate medium, like you're not too sure how much weighting to give to the CD ROM whereas if you knew that everything on the CD ROM was from books even if it gave some general extra information around that, that maybe you can like click into or something but then you could, if you were having a problem with a particular chunk in the book you could go to that and know that you are getting the same information even it fits in a different format, because I was very much like, 'well if I spend a lot of time on the CD ROM is it going to limit me because like I'm learning stuff from it but is it examinable', do you get what I mean? That was the worry.

A small number of students, S7, S10 and S13, reported that they looked at all the sections on the CD-ROM but did not believe it worked well as a learning tool. These students reported differing explanations for why they believed the CD-ROM did not provide a positive learning experience. For example, S7 reported that, like the books, there was too much information to take in from the CD-ROM. For S10, the CD-ROM was felt to be a complete departure from the manner in which she was used to experiencing the course material, see the excerpt below:

S10: The language is completely different on this [the CD-ROM] and you are just getting your head round all the scientific language in the book, the audio tapes and the TV programmes and then they are suddenly speaking in a very different language. This is so different to what you are

> *used to reading in the books... this [the CD-ROM] was...a bit chatty and chatty is fine if the whole thing [the course] was done the like that but it wasn't. It was very much scientific research, proof and suddenly you have this chatty programme and a man talking really slowly and it is funny because it is like a whole different pace you are suddenly meant to manage and you think 'well on a computer it's meant to be quicker' and it actually feels slower and everything feels like I have to wade through stuff.*

Interviewee S13 reported in the interview that there was little to be gained from the CD-ROM believing that the books were better for understanding the information and integrating written information with diagrams. This was in contrast to the views of most of the students interviewed. They reported that they used the text based course material first and the CD-ROM clarified, reinforced or added to the understanding of that information. These students were also likely to report being motivated to use the CD-ROM because of the format of the CD-ROM and because of a general value attached to using computers.

7.6. Tool Management

Tool Management, as a class of strategies, attempts to offer an account of how students used the CD-ROM. The inclusion of the term 'Management' in the title reflects the common theme that emerged from talking to students in this and Studies II and III, that those behaviours resulted from working within the confines of a larger study schedule which placed limits on time.

In Study II, the findings from the eight interviews indicated specific behaviours related to using the Tools on the CD-ROM and the general layout of information on the CD-ROM. There was some difficulty, however, in identifying strategic behaviour from these reports and of all the strategy classes Tool Management, offered the most speculative account of students' CD-ROM behaviour. The findings that emerged in the study reported in this chapter clarified the nature of some strategies identified earlier in the research programme and revealed new strategies to account for the students' use of the CD-ROM.

7.6.1. Tool Use

This strategy refers to the use of the Glossary, the Camera, the Album and the Notepad facility. The Glossary provided an electronic glossary which allowed searches to be made for specific items or items grouped under letters of the alphabet. The Camera allowed a picture to be taken of the image on the active screen of the CD-ROM and then placed this image in the Album. The Notepad facility opened up the simple word processing program that is made available with Windows operating systems.

In the interviews only one student, S20, reported that he repeatedly used the tools on the CD-ROM. Three students reported not looking at the tools at all (S8, S11, 13) because they believed they lacked the ability to use those aspects of the CD-ROM. The majority of students, however, reported that they had an initial look at the tools and then decided

not to use them. Often students reported that curiosity led them to explore the tools initially but decided not to use the tools because of one or more of three factors. A common reason that students gave for not using the tools, particularly the Camera and Album facilities, was that *they could not use the tools*, reported by S1, S4, S6, S7, S16, S17 and S18.

An example of this is given in the excerpts from the interviews with S4 and S17. In the case of S17 the report is particularly interesting because inability to use the facility is attributed to a lack of computing experience and the student's view of CD-ROMs being rare and novel learning tools:

> *S4: ...I tried to use the camera because I thought, 'oh that's a nice idea "take a picture and maybe print it out" but it wouldn't work properly. I got the first picture and I couldn't figure out how to clear it so that I could have another picture...so I just got this one picture that I didn't even want because I had taken a picture of something and wanted to see how it worked and then I was stuck. It would have been nice to have been a bit more easier to use and I don't know whether you could have printed it or moved it to another place or whatever.*
>
> *INTERVIEWER: Can you open the Album for me.*
> *S17: [OPENS ALBUM FACILITY] This is where I feel you need to be a lot more computer literate when you started.*
> *INTERVIEWER: So how do you think we could have made that clearer?*
> *S17: The problem is I don't think you could have made it any easier, I think I needed a few more computer lessons in general...which perhaps the majority of people who use the CD-ROM, like my husband, could use that [the Album facility], understand how to click all these little icons, whereas the most I use a computer for is to word process. I don't think you could have made it any simpler on the CD. I personally need to be more au fait with the computer and how to use these computers.*
> *INTERVIEWER: Did you feel that as you were using the CD-ROM?*
> *S17: Not for anything else, but for the tools.*
> *INTERVIEWER: Did that put you off using the tools then?*
> *S17: Oh yes definitely, I just felt it wasn't worth me spending the time using in them in that way. If there was a CD-ROM with every course and that was the norm and then yes you would get...I would have spent the time getting to know how to use them.*
> *INTERVIEWER: Have you got the Album open...What do you think about that facility.*
> *S17: I think it's a waste of time, I can't see why you would want to print it but then it would look like it looks now.*
> *INTERVIEWER: Did you ever want to put some of the images in your TMAs?*
> *S17: Yes, I did, I bought a scanner now, but yeah.*
> *INTERVIEWER: Well that's what you could with it, cut and paste, and you could also annotate it.*
> *S17: Oh right, but it's time consuming.*

The issue of time as reported by S17 was echoed by a number of students. Specifically, the *belief that there was not enough time to learn and use the tools* was another reason why students did not use the tools as reported by S5, S12, S14 and S18 (see excerpt below).

S18: [CLICKS ON TOOLS] Now, I had problems with Tools. I abandoned them. I couldn't use it. I did have a go, the PhotoAlbum this was where you could print the photographs but I never managed to do that so I didn't actually needed it. I remember having a go...you see the problem is time. You haven't got a lot of time so you are only going to do things that you find really really useful. So I tried doing the PhotoAlbum, found that I couldn't achieve it in the time that I had given myself to mess about with it that day. Because the Album was only going to put that image I presumed on to a piece of paper but its there anyway [on the screen] so I didn't bother.

A final reason given by students for not using the tools on the CD-ROM was the *belief that using the tools would not be beneficial.* With these reports it is interesting to note that some students reported that there would be no benefit in using the tools based on a presumption of what they could be used for, see the excerpt below from the interview with S1. Other students however, reported that they believed the tools offered no learning benefit after trying to use them, see excerpt from S15 below:

INTERVIEWER: You mentioned coming back to the material on the CD-ROM, do you think you will use those two tools I have just shown you?
S1: I think I will. I think I will also take time just to go through all the of the CD-ROM just to make sure there isn't anything else I've missed. I was all the time concerned I was missing things. I knew I hadn't used the tools but I saw the calculator and I knew calculators. I saw the notebook and I think I needed the notebook so I just dismissed the rest. It wasn't immediately apparent to me what it would give me so I didn't even look.
INTERVIEWER: So if I have this right? Was one of the reasons you weren't exploring these tools also because of time constraints?
S1: Yes. I was trying to do the minimum. I was trying to get the maximum information from the minimum time and minimum input. So anything I regarded as an optional extra I didn't pursue and I thought tools were an optional extra.

INTERVIEW: Did you ever use those two tools?
S15: I had a mess about with it to see what it did but I didn't actually use it.
INTERVIEW: What made you decide not to use them?
S15: I couldn't see how it would provide me with any more information or extra benefit.

Even when shown the tools, most students stated that one or a combination of these factors would have still made them reluctant to use the tools on the CD-ROM whilst studying the course. Thus, in exploring the use of the tools on the CD-ROM what emerges is a motive for initially exploring or using the tools – curiosity. From this follows an appraisal process of the tools framed by what can be considered three questions as shown in figure 7.2. below, upon which the use of the tools is based.

The appraisal process of the Tool Use strategy is shown in Figure 7.2.

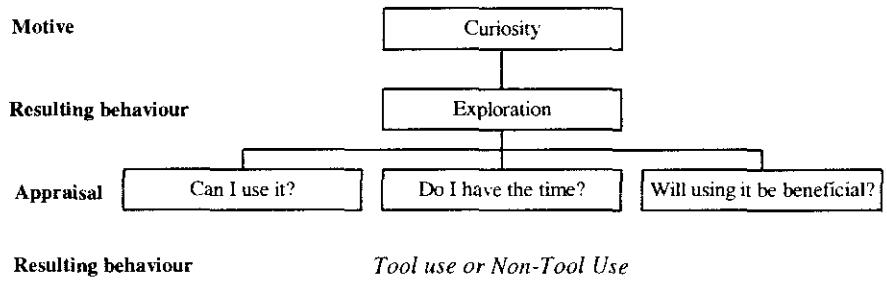


Figure 7.2: The Tool Use strategy

7.6.2. Navigation

This section details navigation behaviour that emerged from the reports of the twenty students and accounts for movement around the various sections and features of the CD-ROM. This strategic behaviour had two main components, that is, the nature of exploration and whether it came to be assisted by a system incorporated in to the CD-ROM to aid navigation.

Most students reported finding the CD-ROM easy to navigate and that they experienced no serious problems in moving around the information (S1, S2, S3, S4, S5, S6, S7, S9, S12, S16, S17 and S19). However, when asked about the three-level layer structuring of sections some students (e.g. S1, S4, S9, S11, S15 and S20) reported that this organisation of information led to some confusion. The issue most of the students raised was that they were informed in the How to Use the System introduction that this three-level structuring existed and became confused when the information proceeded to only two layers. Potential solutions to this problem were given by S4 and S20:

> *S4: ...it would have been nice to have known how many levels there were, sort of like a little index at the side that you haven't got a click on and go into. It's just there so that you can tell OK there are several more levels because unless you happen to move the mouse around sometimes you don't know that there's a hot spot and so it's a chance whether you get into the little bits and pieces. I think there might have been a show hot spot but unless you happen to remember to put it on or whatever but if there was like a little indicator somewhere to say like if you want more information on this screen, do something, this is an interactive screen or a non interactive screen and how many levels there were because unless you go down you don't know how many levels you've got to go. Sometimes you forget. You know that there is another level because you are looking at whatever and you just go, start going that way instead of that way if you get what I mean...it's just that because you are concentrating on it you don't always remember to go down, you go across instead. I think it does tell you that it's one of three or whatever but there's still all the bits like it*

says one of three but within those one of three you've got other things that if you click on you go into a different place, like sometimes it links into other areas and like unless you happen to find that bit you don't know, and you don't know what else is there, and can I go into some other bits from here and it's like getting a bit complicated.

INTERVIEWER: What would you say about the information on the CD-ROM in comparison to the information in the other course material?
S20: It was good and quite concise. The links were good but you had to be patient and take your time through them. So you could get lost if you weren't careful. I think a more Windows Explorer type set up would have been nicer, the tree structure on the left hand side that usually appears you could actually see where you'd come from and how it was related to the other sections would have been my choice of thing. But it was quite straight forward to use really.

A more critical appraisal of the style of the CD-ROM and its impact on navigation was given by S13 who reported that:

S13: ...with the CD, I think there were too many buttons involved in going backwards and forwards and up and down in the subject.

INTERVIEWER: How do you think they could have overcome that?

S13: I suspect that we need a bit more letting the subject go without interruption so you can concentrate on the subject rather than the mechanism. The pieces were too small...you see in a way I think the CD-ROM would be improved in its current state if you started the learning with this CD and got as much out of this as you could from roaming around it, up and down, backwards and forwards with it and then go on to the books. But there is nothing, as far as I can remember, in the CD that talks about the books and vice-versa, they're sort of completely separate things and you're not quite sure what their relationship is supposed to be.

For S13, a major issue in using the CD-ROM was ambiguity surrounding its role in the study of the course. To an extent the cognitive strategies described in the earlier section identify the role of the CD-ROM as one of acquiring knowledge and understanding, along with testing what has been learnt. However, these processes or activities are, to an extent, determined by the manner in which the CD-ROM is explored.

The findings from the interviews indicated that there were two main approaches to dealing with the information on the CD-ROM. The most common approach was for students to go through all the screens in a section, to click on all the hotspots and generally examine every piece of information on the CD-ROM. This behaviour was described as "general discovery" by S14. The excerpt from S19 is typical of students who reported this type of behaviour:

INTERVIEWER: When you were looking at a screen for one of the sections on the CD-ROM, how did you actually know what to click on?

S19: The arrow [the cursor] changed.
INTERVIEWER: So did you go around the screen with the mouse looking for things to click on?
S19: Yes.
INTERVIEWER: Did you click on everything that you could?
S19: Yes, anything that changed. Curiosity.

However, some students reported a more discerning approach to the information on the CD-ROM (S5, S7, S10, S12 and S18). When these students selected the information or hotspots they examined, the basis of this process of selection was often attributed to a lack of time to fully explore the CD-ROM, see excerpts below:

INTERVIEWER: If I were to click on that Text button, again that first screen appears in the section, it's brought up some text about what you are seeing on the screen. Did you go through all the text buttons available on the CD ROM?
S5: I think most of it yes, I wouldn't say every single piece though, but most.
INTERVIEWER: So were you quite selective about the text that you were reading in terms of those text buttons?
S5: Yes but I think that was as much down to time and what I felt I could gain from a certain section and how much time I wanted to spend on it.

INTERVIEWER: That's great, so we move the cursor round the external wall of the auditory canal and it's changed to a question mark. If we click on that what should come up is a pop-up text box, did you go through these Hot Spots.
S5: Yes.
INTERVIEWER: Did you go through all of them.
S5: No I don't think I would have done but the ones that I particularly wanted to look at.
INTERVIEWER: Was it a case of trying to find – was it a case of looking for them or just clicking on the ones you wanted to look at?
S5: I think it was a case of looking at a certain title on the diagram if I wanted to see what extra information was available about that area then I would move across to see if there was a question mark there.

INTERVIEWER: How would you describe the way you moved around the CD-ROM?
S7: Hit and miss. Oh that looks interesting click on that, click on that. Nothing structured.
INTERVIEWER: We have gone through various screens on the CD-ROM and you have seen me call out those numbers in the top corner of the screen [REFERRING TO SCREEN NUMBERS] did those help at all?
S7: What the 1 of 5? Yeah just so you know where you are and you can go back or forward if you want.

Another aspect of navigation behaviour was the Index facility on the CD-ROM. This provided a visual representation of the architecture of the CD-ROM, much like the Windows Explorer facility. Some students reported using the Index facility because it was convenient, allowing them to access immediately particular information on the CD-ROM (S1, S2, S9, S11, S15, S17 and S20). However, other students either chose not to use it or did not consider using it because they reported a preference for exploring the CD-ROM of their own accord. Having been shown this facility, S6, S7, S16 and S19

reported that they wished they had used it, whereas S8 and S12 reported that they would not have used it given the opportunity again.

7.6.3. Use of Support Facilities

This section refers to behaviour related to two important support facilities on the CD-ROM: the instructions presented in the section 'How to use the system' and the ability to save records of one's progress through the CD-ROM. A support facility is defined here as an element or mechanism that supports the delivery of information on the CD-ROM and in so doing supports the learning process.

Different motives and behaviour emerged in relation to using the two support facilities. As a result a sub-strategy was proposed to account for the use of each of the facilities. These representations of behaviour are considered sub-strategies because together they lead to a greater understanding of the use of support facilities. However, individually they enable an understanding of why a particular facility came to be used or not used. In the case of each sub-strategy, a particular motive was discovered to lead to the facility either being used or ignored.

The first sub-strategy detailed here relates to the use of the instructions section on the CD-ROM. The use of this section could be explained in terms of three motives. For most students examining the instructions was considered to be useful to their overall use of the CD-ROM. This resulted in a number of students (e.g. S1, S2, S3, S6, S8, S14, S16, S17 and S18) using the section before any of the other sections on the CD-ROM and also accessing the section as they worked through the rest of the CD-ROM. A number of other students examined the instructions section briefly on the basis that it may have contained useful information linked to their use of the CD-ROM (e.g. S4, S7, S9, S10 and S20). These students tended to not complete the entire section and examined it only once. Three students reported not using the section at all, S13, S15 and

S19, in each case they reported that this was because they generally did not examine tutorials or instruction that a new program often presented on their computer. There was some evidence in the interviews that these different approaches may be linked to students' previous computing experience (see excerpt from S13 below). The quotes below contrast the different ways in which the 'How to use the system' section was used by different students adopting these three approaches:

> *INTERVIEWER: Did you use the 'How to use the system' section?*
> *S6: Yes, I did the first time I used the CD-ROM.*
> *INTERVIEWER: What did you use it to do?*
> *S6: Just wanted to know how to work it basically, I didn't want to end up going to the wrong thing and doing things in the wrong order and finding that things were not making sense. So, I thought it would sensible to use that first of all.*

> *INTERVIEWER: Could you select 'How to use the System'.*
> *S9: [PERFORMS ACTION AND OPEN SECTION]*
> *INTERVIEWER: So what this is a basic tutorial as to how the CD-ROM works. Did you go through this at all?*
> *S9: I read it briefly but once you got the hang of it you can more or less figure out what it does...although it is useful for somebody who doesn't know how to get around a CD-ROM or a computer screen. It's okay, I just read what I needed to and figured it out from there.*

> *INTERVIEWER: If we could look at the contents screen and look at How to use the system?*
> *S13: [OPENS SECTION]*
> *INTERVIEWER: Did you look at this section at all?*
> *S13: No, I'm a typical experienced user – use it first and then read the instructions afterwards.*

The majority of students interviewed failed to regularly save records of their sessions on the CD-ROM. The reason for this appeared to be an appraisal of the saved records in terms of two factors: whether the records would be accessed at a later time and whether the session was worth saving. Most students believed that even if they saved records of their sessions they were unlikely to access them at a later date. A small number of students believed that their performance with the CD-ROM was so poor that they felt embarrassed about saving records of their progress using the CD-ROM. For example, see the contrasting excerpts below from S4 and S15 about why they did not save records of their time spent with the CD-ROM:

> *INTERVIEWER: When you came to close down the CD ROM it says do you want to save your records.*
> *S4: No I didn't. I probably did a couple of times but like, then I didn't bother maybe when I went back in so.*

INTERVIEWER: Those times when you did save them, what was the reasoning behind saving them?
S4: Because it asked me to so I kept thinking maybe I'm supposed to...once I've been through it [the information] I know where everything is anyway so if I don't understand something I'll retrace my own steps. I know approximately where it [the information in question] is, which bit it's in, and I might pick up some other information along the way.

INTERVIEW: Whenever you started the CD-ROM it asks you whether you would like to load the records of your previous sessions. Did you save the records of the time you spent with the CD-ROM?
S15: No, I didn't.
INTERVIEW: Can I ask why?
S15: Because usually I'd gone through a section and I knew I'd gone through it too quickly, did the questions at the end, got them all wrong and felt 'I'm not saving that, I'm not having proof that I got all that wrong'. That's basically why, I didn't see any reason to save what I'd done because I thought I could always go over it again.

Figure 7.3 shows the two sub-strategies, motives and resulting behaviours that emerged from the reports of student concerning the use of the instructions section and the saving of records.

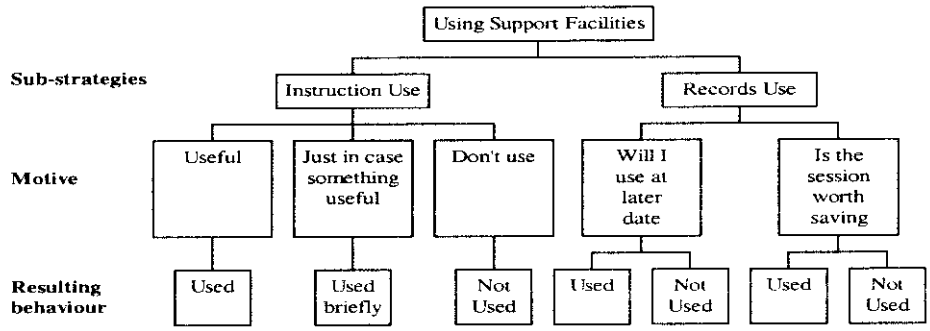


Figure 7.3: Support Facility sub-strategies

7.6.4. Usage

In Study III students were asked to approximate the time they spent using the CD-ROM on the SPOTLITE questionnaire. This estimate was made some two months before the course ended and it was considered that use of the CD-ROM might have extended beyond this period for some students. To that end students were asked to give an estimate of the total time they spent using the CD-ROM.

Initially, this estimate was intended to frame the reports of strategic behaviour that occurred in using the CD-ROM. However, it became apparent from the way students arrived at an estimate of time spent using the CD-ROM that this in itself may in fact be

evidence of strategic behaviour. In the interviews students reported one of four usage strategies.

The most popular strategy was to use the CD-ROM for a number of short periods, often lasting less than thirty minutes (S6, S7, S8, S15, S17, S18 and S20). The next most popular strategy was to use the CD-ROM periodically for long study periods that lasted anywhere between one hour and six hours (S1, S3, S4, S10, S12, S14 and S16). Two other less popular strategies were to use the CD-ROM for a number of long study periods (S11, S14 and S19) or to vary the amount of time spent using the CD-ROM from short periods to long extended periods (S2, S5, S9 and S13).

The adoption of one of these four strategies did not seem to be associated with the adoption or use of any of the other strategies in the remainder of the framework. Usage also had no bearing on other aspects of using the CD-ROM, that is, when the CD-ROM was examined, the examination of screen features and how the CD-ROM was used in conjunction with the other course material.

When the CD-ROM was used - Most students looked at the CD-ROM after they had examined the information in the text based course material. Three students, S3, S6 and S7, reported using the CD-ROM prior to reading the course texts. These students indicated that the CD-ROM as used as an introductory source and made the information in the text-based materials easier to understand.

Screen features – a typical screen on the CD-ROM comprised a diagram with various 'hotspots', commentary and text that could be accessed by clicking on a 'text' button. With few exceptions, most students reported that the first element they examined was the diagram and they attended to the other elements after they familiarised themselves with the image and had explored any associated 'hotspots'.

CD-ROM and other course material – Again, with few exceptions most of the students studied the CD-ROM in isolation from the other course material. This was not explored in detail in the interviews, but one possible reason for this is that studying the CD-ROM meant using a computer that was located in a different place to where students often studied.

7.7. Summary

The aim of the study reported in this chapter was to enhance and refine the understanding of students' computer-based learning strategies that emerged in Study II and Study III. The use of the interview survey method allowed detailed information to be collected about students' study practices with the CD-ROM and also allowed students to be observed using the Tool.

The general information students provided indicted that all had had previous experience of using computers prior to using the CD-ROM although approximately half the sample had five or less years of computing experience. Also, the majority of students had also never used a CD-ROM for academic purposes before. Most used the CD-ROM at home and approximately half the sample explored all the sections on the tool. For most students the most useful sections were the 'Hands on the Brain' and the 'Cerebral Cortex'.

The reports of students were analysed using phenomenological set of principles, described in more detail in Chapter 3, which sought to identify strategic behaviour. Like the other studies three main classes of study behaviour and practices emerged from the accounts of students, again these covered motivation for using the CD-ROM, information processing behaviour and management of the resource.

In terms of motivation, three strategies were identified: Resource Exploitation, Expectancy and Presentation Format. The reports of students indicated that the first two of these strategies prompted the student to start using the CD-ROM whilst Presentation Format emerged as a strategy that could account for the ongoing use of the tool once students started.

In terms of information processing behaviour again three strategies emerged. These included Notetaking, which accounted for the notetaking behaviour of students and Self Testing, which married together behaviour related to the use of the QuickTest and Objectives facility on the CD-ROM. The Knowledge Focused strategy was proposed to account for and clarify the main learning purpose of the CD-ROM for the students who used it. This strategy revealed that imagery was the most useful of the presentation modes on the CD-ROM and that the CD-Rom was used to reinforce information from other course material.

Behaviour related to managing the use of the CD-ROM had in Study II and Study III emerged as difficult to interpret and consolidate meaningfully into strategic study practice. In the study reported in this chapter this was overcome with the presentation of four strategies that included some aspects of study practices from the previous studies. The strategy Tool Use presented an opportunity to extend the notions of why the tools were often explored but not used by the majority of students. Navigational behaviour was accounted for by the Navigation strategy that offered an understanding of the exploration behaviour of students and their use of navigational aids on the CD-ROM such as the Index facility. Two new strategies were also proposed in this study to account for the management of the CD-ROM. The Use of Facilities strategy examined the extent to which the instructions on the CD-ROM and the record saving facility were used and what factors contributed to their use or non-use. The strategy Usage was based on evidence of the time spent using the CD-ROM and how the tool was used in the context of the overall course.

This exploration of strategies across the three classes of Motivation, Cognition and Tool Management, represents further evolution in understanding the nature of computer-based strategic behaviour both across the research project. That evolution and the

implications of the study reported here are presented in the next chapter that discusses the findings from the four studies undertaken which sought to examine the learning strategies of students using the CD-ROM.

Chapter 8

A DISCUSSION OF THE FINDINGS FROM THE PROGRAMME OF FOUR STUDIES

8.1. Introduction

This chapter discusses the findings from the programme of research detailed in the previous chapters of the thesis. The research comprised four studies and adopted a survey approach utilising both questionnaire and interview techniques. The programme of research is outlined in the figure below:

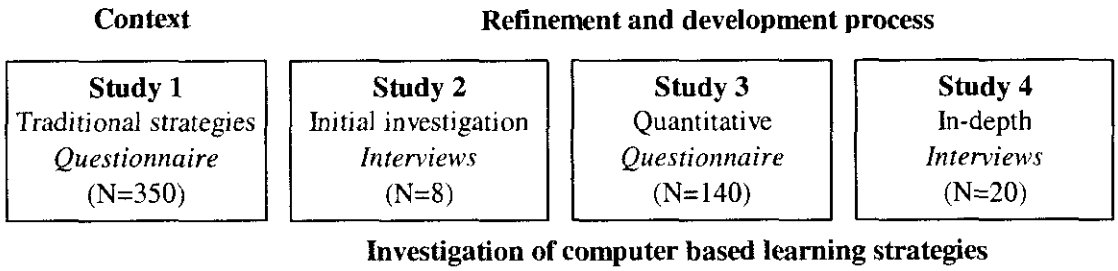


Figure 8.1.: The programme of research associated with this thesis

The programme addressed two main research questions that framed this thesis:

- What learning strategies do students use when learning with computers?
- To what extent do students' computer-based learning strategies differ from the traditional conceptualisation of learning strategies?

The remainder of this chapter is separated into two main sections, each respectively addressing these research questions.

8.2. The computer-based learning strategies of students

In Chapter 2, Section 2.7, the review of the past literature relating to computer-based learning strategies identified two main trends in the research. One trend has been to propose a set of strategies to account for the overall use of computer-based learning system (e.g. Lyman, 1998; Saunders, 1998). The other trend has been to concentrate on the strategies related to a specific aspect of using a computer-based learning system,

most often navigation and searching behaviour (e.g. Hill and Hannafin, 1997; Chang and McDaniel, 1995; Schroeder and Grabowski, 1995; Astleitner and Leutner, 1985).

Section 2.7 also outlined a series of limitations associated with this past research. In terms of research that has focused on identifying strategies mediating the use of a computer-based system, the resulting strategies have been limited in scope and number. For example, Saunders (1998) identifies three strategies, one affective and two cognitive, to account for the overall use of computer-mediated communication learning system.

There are also criticisms that can be made of the research that has focused on specific aspects of using a system, i.e. navigation and searching. This research has often failed to acknowledge the full context in which the behaviour examined occurs, that is, searching behaviour does not occur in a vacuum but is linked to motivation and information processing but these factors have often been ignored (e.g. Astleitner and Luetner). A second criticism is that although this research is reported to examine learning strategies it has monitored 'users' behaviour in often non-academic related computer-environments. For example, Hill and Hannafin (1997) examined the searching strategies of users by allowing them free-reign to search the Internet for a topic of their choice. These users' behaviour was then mapped on to a series of strategies drawn from the research and literature on students learning in the traditional university setting to determine the strategies they used.

This section reports on the findings of three studies that examined the computer-based learning strategies of students. In the first study, Study II in the overall research programme, eight students were interviewed about their use of the Human Brain CD-ROM during the study of the SD206: Biology, brain and behaviour course. In a subsequent study, the findings of Study II were examined on a larger scale using a

questionnaire completed by 140 CD-ROM users. Finally, the findings from both these CD-ROM studies were examined in light of the reports of twenty students who were interviewed about their use of the CD-ROM and observed using the technology.

Throughout the research programme, the aim of the interviews and the questionnaire was to explore the range of behaviours students adopted in relation to using the CD-ROM in the real context of studying the course Biology, Brain and Behaviour. To this end, the research programme addressed the methodological issues associated with past research that has examined the computer-based learning strategies of students.

It was evident early on in the research programme that the computer-based learning strategies of students could be separated into three main types or classes of strategies: motivational strategies; cognition or information processing strategies; and tool management strategies. Over the three CD-ROM related studies, notions about what strategies fell into these classes and mediated the use of the CD-ROM became developed and refined. The following sections outline this framework, or set, of strategies beginning with the motivational strategies, cognitive strategies and, finally, tool management strategies.

8.2.1. Motivational Strategies

In Study II, the analysis of students' interview transcripts revealed four motivational strategies, In Study III, factor analysis of students' responses to a questionnaire designed to examine the computer-based learning strategies produced four similar motivational strategies to those identified in Study II. In Study IV, however the reports made by students indicated that motivation for using the CD-ROM could be rationalised in terms of three strategies. These three strategies were: Resource exploitation, Expectancy and Presentation Format.

In all three studies ***Resource Exploitation*** emerged from students' reports that they used the CD-ROM because of its availability as part of the course material. This strategy was often associated with reports by students that they used all available course materials, e.g. printed text, videos, audio-cassettes and that they equated success on the course with the use of all the available resources.

The strategy ***Expectancy*** also emerged in studies II, III and IV. It represented being motivated to use the CD-ROM by a set of expectations students formed about the technology prior to its use. These expectations typically included notions about how the information on the CD-ROM would clarify concepts, add to their understanding of the subject matter presented in the other course material and produce greater success in learning the course content.

The expectations reported about the CD-ROM reflect the findings of a study at the Open University examining the perceptions of students towards an early computer-assisted learning (CAL) system (Jones and O'Shea, 1982; Scanlon et al, 1982). The system investigated provided diagnostic feedback and remedial help system and was designed for students on a predecessor of the Biology, Brain and Behaviour course. The study found that students reported a series of advantages and disadvantages associated with using the system even before they used it. Amongst the perceived advantages were 'finding and correcting weak points' and 'consolidates understanding and clarifies main points' (Jones and O'Shea, 1982; Scanlon et al, 1982).

In all the CD-ROM related studies, the strategy ***Presentation Format*** reflected a comparison made by a number of students about the way the information was presented in the text-based course material and the CD-ROM. This comparison often reflected positively on the CD-ROM, with students reporting that it provided a different approach - a more detailed and tangible description of biological structures than the printed text.

However, in some cases students felt the opposite was true, that is, the printed materials presented information in a manner that was easier to understand. In either case, these experiences were regarded as evidence of motivational behaviour because a positive view of the way the CD-ROM presented information led to increased use of the technology whilst the opposite was true if the view of the CD-ROM was negative.

The positive comparison of the CD-ROM to other course material echoes the findings of Jones and O'Shea (1982) and Scanlon et al (1982) who also found students appreciated using a series of early CAL systems at the OU because they offered a new approach to the subject and a means of making learning fun.

In Study II and III, along with Resource Exploitation, Expectancy and Presentation Format, a fourth motivational strategy was assumed to account for students' motivation for using the CD-ROM. This strategy was identified as 'Perceived value of IT' and emerged in both the interviews in Study II and the questionnaire used in Study III. This strategy represented motivation for using the CD-ROM based on a general view of information technology as a useful and valuable resource in everyday life and in learning. However, the reports of students in Study IV clarified that this was not a separate strategy but rather it reflected components of the Expectancy and Presentation format strategies.

In terms of Expectancy, it reflected an expectation about the nature and level of interaction that students would encounter when using the CD-ROM technology. In terms of Presentation format, reports made by students that they used the CD-ROM because it "offered something different" and "offered a convenient way of accessing information" echoed components previously attributed to the Perceived value of IT strategy in Study II and III.

This re-appraisal of the Perceived Value of IT strategy occurred in Study IV because there were number of incidences across the twenty interviews where students married these components together. Also, compared to Study II where only eight students were interviewed, there was a more detailed insight into the learning experience using the CD-ROM. However, in Study III there was some indication of a relationship between general views about IT and the Expectancy and Presentation format strategies when responses from question 7 (*I believe one reason why computers can be considered useful is that they can present information differently from books*) were found to be related to both strategies.

8.2.2 Cognitive Strategies

In Study II and III, four cognitive strategies accounted for the information processing behaviour of students. These included: a Knowledge Focused strategy; Notetaking strategy, Self-Testing strategy and Objectives strategy. However, the findings of Study IV indicated that the Self-Testing strategy could account for behaviour previously ascribed to both the Self-Testing and Objectives strategy in Study II and III. Therefore, in total, three cognitive strategies emerged from the research programme: Knowledge Focused, Notetaking and Self-Testing.

Consistently, throughout the three CD-ROM related studies, the ***Knowledge Focused*** strategy represented the CD-ROM being used to understand, clarify and reinforce the information students encountered in the other course material. It can be seen as the cognitive strategy focused towards accomplishing the objectives of effective web-based learning reported by Lyman (1998) although these objectives could equally apply to a multimedia-based system such as the CD-ROM. These objectives include: knowing when there is a need for information; identifying information needed to address a given

problem or issue; locating, evaluating and organising information; and using information to effectively address the problem or issue at hand.

The ***Notetaking*** strategy emerged in Study II from questions directed at students' use of the Wordpad tool on the CD-ROM. The Wordpad facility allowed students to access the basic word-processing application available with Microsoft Windows operating systems. Students were asked in the interviews if they had used this facility to take notes and in most cases they reported they did not. This led to some students reporting that they had made hand written notes but the identification of the strategy was based on two main factors. Firstly, when notetaking was reported it was described as a separate activity from the cognitive processes linked to the Knowledge Focused strategy. That is, in talking about the 'Knowledge Focused' related behaviour, most students spoke about abstract processes such as understanding and clarification but, on the whole, reported that they did not make notes from the CD-ROM. This means if notetaking is related to the Knowledge Focused strategy then we would expect most students to have made notes from the CD-ROM and that was not the case.

The second reason for considering notetaking as a distinct strategy was that students often reported a rationale associated with their note producing behaviour. Whilst Study III confirmed that few students made notes from the CD-ROM, Study IV clarified why some students did and others did not make notes. In Study IV, most students reported that they failed to make any notes from the CD-ROM because they made notes from the other course material and felt that further notes from the CD-ROM were unnecessary. Overall, the conclusion most students reached was that notetaking from the CD-ROM was not important.

In the instructions students were not told they had to make notes from the CD-ROM. Therefore, it is not known if notetaking were encouraged whether students would have

made more notes, i.e. adopted a high-level Notetaking strategy, and whether it would have been a beneficial activity for students. We can draw some insight from a study conducted by Armel and Shrock (1996). They found that when students were forced to make notes from a computer-assisted learning programme they would take more notes than a group studying the same system but given the option of taking notes. The forced notetaking group also spent more time using the system and they did better in recall of information from the system than the optional notetaking group. A third group of students who were not told they had to make any notes made no notes, spent little time using the system and scored the lowest scores on a test of recall based on the system's topic. Laurillard (1998) also provides evidence from research on the Homer system, a humanities CAL system designed at the OU, that electronic notetaking will take place when encouraged and highlighted as important.

The ***Self-Testing*** strategy was the final cognitive strategy to emerge from the CD-ROM related studies. Based on the findings of Study IV, this strategy accounted for behaviour that in earlier studies had been thought to be accounted by two strategies: Objectives and Self-Testing. In Study II and III, the Objectives strategy referred to the use of the Objectives facility on the CD-ROM. The facility provided students with a list of learning outcomes that they were expected to have achieved when they completed a particular section. These objectives could be accessed for each section at any time whilst working through that part of the CD-ROM. The Self-Testing strategy referred to the use of the QuickTest facility on the CD-ROM that provided students with a set of questions they could go through at any time whilst studying a particular section of the CD-ROM. In both Studies II and III, it emerged that students were using the QuickTest facility as a checklist of what they had learnt having gone through a particular section. In Study II there was some indication that this checklist behaviour also applied to the

use of the Objectives facility on the CD-ROM. The findings of Study IV indicated that the use of the QuickTest and Objectives facilities was related, that they were both used as checklists and could be accounted for by a single strategy that was termed Self-Testing.

Furthermore, in allowing students to freely access the Objectives and QuickTest facility on the CD-ROM, a series of what were termed Use and Feedback behaviours or sub-strategies, essentially components of the strategy, were reported by students. These sub-strategies represented: when the QuickTest and Objectives were accessed and used by students whilst studying the CD-ROM, along with, what students did with the feedback they received when responding to questions in the QuickTest facility. These components, along with why students used these facilities on the CD-ROM and what they reported using the facilities to test, were regarded as important components of the Self-Testing strategy.

In all three CD-ROM studies, a large proportion of students reported using the Quick Test facility. The fact that this feature of the CD-ROM was popular with students could be accounted for by a finding of Lockwood's (1992) work: that students are more likely to attempt and complete activities that have certain characteristics. These characteristics include: requiring a mental response rather than an extended written account; an intellectual response based on recall or comprehension, rather than interpretation or analysis; and also provision of a grid or framework in which to make a response, such as a tick. These features that Lockwood found increased responses to activities in text-based materials were present in the QuickTest facility, and to an extent the Objectives facility, and arguably had an impact on the Self-Testing strategic behaviour of students.

8.2.3. Tool Management Strategies

Tool management refers to a class of strategies that accounts for how students managed and spent their time using the CD-ROM. In Study II and III classifying behaviour in terms of Tool management strategies proved difficult compared to a similar analysis carried out for the motivational and cognitive strategies. This difficulty arose because students' attitudes and opinions about using the CD-ROM were included in the analysis of strategies when only behaviour or activity they reported should have been included. This misinterpretation was highlighted when the factor analysis carried out in Study III produced few strategies that were comparable to those found in Study II.

The reports of students in Study IV offered a more comprehensive analysis of how students used the CD-ROM, firstly because the interviews were directed towards behaviour and activities linked to using the CD-ROM rather than opinion or attitudes. Secondly, students' accounts were compared across a range of twenty interviews that also included observation of behaviour with the CD-ROM. Like Study II, the information in Study IV was analysed in terms of dominant themes or common aspects of students' experiences using the CD-ROM. However, in the final study of the research programme, only reported behaviour or activities were considered as evidence of strategic behaviour.

In total four strategies were proposed after analysis of the interview data collected in Study IV, these included: Tool Use; Navigation; Use of Support Facilities and Usage.

The strategy ***Tool Use*** offers an account of why students used, or, as was more often the case, did not use the tools available on the CD-ROM, i.e. Camera/Album, Wordpad and Glossary. The strategy ***Navigation***, accounted for the movement of students through the information available in the sections of the CD-ROM. The ***Use of Support Facilities*** strategy accounts for behaviour linked to facilities on the CD-ROM considered by its

designers to support its use. Such facilities included: the instructions on how to use the system and a facility that saved and stored a history of the screens visited by the student in particular session spent using the CD-ROM. These strategies account for quite different behaviour but they shared a common element - a cost-assessment exercise performed by the students that had been evident to some extent throughout studies II and III.

This exercise is similar to the cost-benefit analysis students perform described by Lockwood (1992) in terms of activities in traditional text-based course materials used in distance and open learning. With this set of materials the assessment is characterised by a weighing up of the benefits of performing various activities against the cost, in terms of time, incurred in responding to them.

However, whilst Lockwood found time was the only factor considered by students in their appraisal of whether activities should be completed, the use of the CD-ROM also included an appraisal by the students of their ability to use the technology and the benefits offered in learning the course content.

In terms of the ***Tool Use strategy*** and tools on the CD-ROM students would carry out one of three cost-assessments, essentially, asking the following questions: i) could they use the tools available?; ii) did they have the time to learn the tools available? and iii) would using the tools prove beneficial to their learning of the course content? In most cases students made the assessment that they either did not have the time to learn how to use the tools or that using them would not benefit their learning of the course. In fact, one of the trends identified across the three CD-ROM related studies was for students to report that they did not use any of the tools on the CD-ROM, this was their Tool Use strategy. However, whilst there was no doubt that this cost assessment of the tools existed in analysing the reports of students in Study IV, and to some extent II and III,

there was some doubt about the informed nature of students' appraisals. This came to light when students were shown how the tools could be used. In many cases, students responded that if they had known, or had been fully informed about what these facilities could do, they would have used them.

A cost-assessment exercise was also found to be relevant to students' ***Navigation strategy***. That is, students reported that they either went through the entire content of a section or were selective about what they examined. This navigation behaviour was based on the time available and whether students believed that greater understanding would be gained from a selective or non-selective approach to the content. The behaviour linked to selective or non-selective viewing of a section's content was considered a Navigation strategy. The strategy mirrors the findings of Verheij et al (1996) who also found that learners were either likely to follow the sequence of screens in system, termed a linear strategy; or were selective, and more likely to follow a path of related information across the system, which they referred to as a text-relation strategy. Schroeder and Grabowski have also identified this behaviour but have considered selective viewing behaviour as a conscious strategy and non-selective behaviour as a passive strategy. In light of this we can consider the Navigation strategy to have two extremes: a passive/non-selective passage through the screens and a conscious/selective way of navigating the information. It was also found that these navigational approaches did not appear to be related to the cognitive strategies identified in the previous section of this chapter. That is, the extent to which students reported, for example, Knowledge Focused behaviour, was not associated with a passive or conscious navigation approach.

Navigational approach was also independent of whether the Index facility was used by students in their study of various sections on the CD-ROM. The Index facility provided students with a hierarchical map outlining the screens in section and although about half

the students in Study IV reported they used this facility regularly, these students did not all report the same navigational approach. In Verheij et al's research constant use of a similar facility to the Index system was rationalised as a separate navigation strategy called a 'Map strategy'. The findings of Study IV, however, indicate two main navigational strategies similar to those found by Verheij and colleagues that can both involve use of a map/Index facility but not a separate Index strategy.

Along with the Tool Use and Navigation strategies, the ***Use of the Support Facilities*** strategy also embodied a cost-assessment exercise. The strategy addressed the use of two separate facilities on the CD-ROM: the How to Use the System tutorial and the Records facility that saved a student's progress through a section. Whilst they are distinct components of the CD-ROM, they are both design features that support the delivery of information and in so doing support the learning process. The cost-assessment exercise linked to these two facilities involved an appraisal of how useful the features would be to the students' learning of the course content.

The three strategies examined so far, Tool Use, Use of Support Devices and Navigation, account for how students managed a typical session using the CD-ROM. The interviews in Study IV, however, also provided a picture of how much time students spent using the CD-ROM. Initially, it was thought that asking students about the amount of time they spent using the CD-ROM would only serve to frame the strategic behaviour outlined in the strategy framework. However, the way students arrived at this estimate (total time = number of sessions per week x average amount of time spent using CD-ROM in each session) indicated evidence of strategic behaviour related to the management of time and effort spent using the CD-ROM.

The final Tool Management proposed was termed a ***Usage strategy*** comprising four main components: the length and number of sessions in which students used the CD-

ROM; when it was used in relation to the course material; what features of the screen were primarily examined and how the CD-ROM was studied alongside the other course material. Students differed in the amount and length of sessions spent using the CD-ROM, often they used the technology after they had exhausted their learning of a topic from the other course material and almost all students studied the CD-ROM in separation from the other course material.

An important finding in all three CD-ROM related studies was that use of the technology was an overall positive learning experience but that the experience was marred by a lack of clear instructions relating to how the CD-ROM should be used and what purpose it should serve in the study of the course. If these instructions had been provided, the Usage strategy would provide a good indicator of how well the instructions were followed when it came to using the CD-ROM.

So far, this section has explored the strategies related to the CD-ROM in terms of the framework associated with the MSLQ. This comparison determined similarities in the classes of strategies that students use in traditional and computer-based learning contexts i.e. motivation, cognitive and resource/tool management. There were also some similarities between the strategies that make up these classes across the two learning contexts, but on the whole these strategies were quite different. However, the proposed framework of computer-based strategies also embodies characteristics of other conceptions of traditional learning strategies.

For instance, Dansereau (1978) distinguished between primary and secondary strategies, where the former refers to information processing, and the latter refers to behaviours and processes that support the primary strategies. This distinction is reflected in the computer-based set of strategies by a set of cognitive and tool-management strategies.

In the 1980's models of learning strategies included motivation as an important component of strategic behaviour (e.g. Weinstein and Mayer, 1985; Weinstein, Schulte and Palmer, 1987; Zimmerman and Pons, 1986) and motivational strategies were found to be a key component of the learning experience with the CD-ROM.

Also, Rigney (1978) claimed that learning strategies could be facilitated by the teaching material or by the individual. This reflects a distinction between the motivation and cognitive strategies, arguably strategies facilitated by the individual, and resource management strategies, which are strategies to emerge in response to properties of the CD-ROM, i.e. they are facilitated by the teaching material.

Another distinction is drawn by Biggs (1984) between macro-strategies, meso-strategies and micro-strategies. Macro-strategies are general behaviours to emerge from cultural of stylistic approaches. Meso-strategies represent typical study behaviours. Micro-strategies are task or domain specific abilities. With the exception of the Resource Exploitation strategy, all the CD-ROM related strategies could be considered micro-strategies since they are specific to the use of the CD-ROM. However, the Resource Exploitation strategy could be considered a meso-strategy since it represents typical study behaviour, i.e. the study of all available course material.

8.3. Differences between computer-based and traditional learning strategies

One of the main aims of this thesis has been to determine the extent to which students' computer-based learning strategies differ from learning strategies used in the study of traditional course material. Why is it important to determine the differences between computer-based and traditional learning strategies?

Computer-assisted learning and online-teaching are becoming increasingly popular, however, these new technologies are often still used alongside a number of traditional

teaching tools and methods. If the strategies students use when studying with traditional teaching tools and methods differ from those strategies linked to the use of CAL systems then these differences are important to consider when evaluating those CAL systems.

Chapter 3 reported on the first study in the programme of research, Study I. The aim of that study was to examine the reliability of a learning strategies framework originally developed from testing with traditional college students in the US – the framework chosen was associated with the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al, 1989). The investigation was intended to determine whether the framework was suitable for determining the study practices of a population of distance learners in the UK. The purpose behind establishing this framework's reliability on this particular population was so that it could be used to frame the examination of computer-based behaviour in the remainder of the research programme. Thus, the findings of the Study II, III and IV were initially analysed for strategies found in the MSLQ framework and when these failed to appear the strategies discussed in the previous section emerged.

The findings of the Study I indicated that the MSLQ was reliable when tested on this population. Also, students on the Biology Brain and Behaviour course were using a series of motivational, cognitive and resource management strategies similar to those used by students in the traditional universities and colleges in the USA where the MSLQ had originally been developed. This reflected the findings of previous research that has found that models and measures of strategic behaviour, other than the MSLQ, but also initially developed in the USA, applied equally well to students studying at a distance education in other parts of the world (e.g. Köymen, 1992; Olgren, 1996).

Having shown the MSLQ to reliably represent the learning strategies of students when studying traditional course material, the findings of Study II, III and IV, could then be

compared against the MSLQ framework. This comparison revealed that strategies from both the traditional and computer-based learning contexts could be grouped into the same classes of strategy, i.e. motivation, cognitive and resource/tool management. However, strategies between these two learning contexts differed in terms of the *types* of strategies that comprised these classes.

Differences between the types of strategies mediating the study of the traditional course material and the study of the CD-ROM were apparent early on in the research programme. However, a clearer picture of these differences emerged following all three CD-ROM related studies and the finalised framework of strategies relating to the use of the CD-ROM.

In terms of ***Motivation***, Study I indicated that the study of the traditional course material could be represented by the six motivational strategies measured by the MSLQ:

- *Intrinsic goal orientation* – motivation based upon the desire to master the domain/task being learnt along with interest or curiosity in the domain/task
- *Extrinsic goal orientation* – motivation based on achieving high grades/awards or approval from others, with little importance placed on the learning domain/task
- *Task Value* – importance placed upon completing the task or understanding the domain, and the perceived usefulness of the task/domain as part of a programme of study
- *Control of Learning Beliefs* – extent to which students believe their success on a task is dependent on their own effort
- *Self-efficacy for learning and performance* – the extent to which students believe they will successfully complete the task in question

- *Test Anxiety* – how a student feels about test taking and exam preparation and is generally characterised by a pre-occupation with assessed performance

The findings of study II, III and IV, indicated that motivation for using the CD-ROM could be accounted for by three strategies: Resource Exploitation, Expectancy and Presentation format. To a limited extent, these strategies embodied elements associated with some of the strategies from the MSLQ.

For instance, Resource Exploitation reflected the effort-to-success relationship outlined in the 'Control of Learning Beliefs', in that students believed that success on the course was linked to the effort they put into examining all the course material. However, the difference between these two strategies is that 'Control of Learning Beliefs' relates to students' notions about their effort and its impact on success, whereas Resource Exploitation relates to the actual effort/actions of students using the CD-ROM.

Another similarity between the computer-based and traditional strategies was that all three CD-ROM strategies embodied aspects of intrinsic motivation similar to the Intrinsic goal orientation strategy included in the MSLQ framework, i.e. use of the technology based on interest, curiosity or a learning advantage. However, a notable difference between the motivational strategies associated with the CD-ROM and the traditional course material was that there was no mention of strategic behaviour associated with extrinsic motivation or test anxiety strategies. That is, few, if any, comments were made by students that they were studying the CD-ROM because they just wanted to get a high grade or because they were anxious about assessments linked to the study of the course.

In terms of ***Cognitive*** strategies, in the MSLQ framework there are two general components related to this class of behaviour: 'cognitive' and 'metacognitive'. Three

strategies measured by the MSLQ are considered 'cognitive' measures: *rehearsal, elaboration, organisation and critical thinking.* These strategies are used by students in a number of learning contexts, including: the lecture, tutorials, studying with peers and individual study and are based on the conceptualisation of cognitive strategies by Weinstein and Mayer (1985).

- *Rehearsal* strategy - commonly adopted for simple tasks and often takes the form of rote learning.
- *Elaboration* strategy - can be considered a deep strategy because it enables students to adjust or supplement prior understanding. In terms of study behaviour, elaboration is characterised by paraphrasing, note-taking or the creation of analogies
- *Organisation* strategy - refers to the evaluation of information for most important information and the forming of connections between pieces of information
- *Critical thinking* – refers to the extent to which students apply previous knowledge to a new situations in order to solve problems or make critical evaluations

Whilst the nature of the cognitive strategies that students use is relatively straight forward, the specification of 'metacognitive' behaviour is comparatively difficult. Metacognitive behaviours refer to an awareness, control and monitoring of learning activity and are considered an important aspect of the learning experience (Pintrich, Wolters and Baxter, 2000) The problem of interpreting metacognitive behaviour lies in the fact that these behaviours are often implicit to the student and difficult to interpret from the self reports of students (Pintrich, Wolters and Baxter).

In all three CD-ROM studies, the reports of students were examined initially for behaviours that reflected the cognitive strategies included in the MSLQ. There was evidence of information processing behaviour but it was difficult to classify this in terms of the cognitive strategies identified in the MSLQ framework. What presented the most difficulty was identifying behaviour that could be classified as metacognition. Consequently, with this difficulty and the caution offered by Pintrich (2000) about the intricacies of metacognitive behaviour, it was decided not to examine metacognition any further in Study II and to exclude it from the analysis of data in the remainder of the studies. Therefore, the cognitive strategies that emerged in relation to using the CD-ROM accounted for the encoding and understanding of information using the technology and revealed a series of differences between traditional and computer-based strategies.

To some degree, the Knowledge Focused strategy linked to the CD-ROM reflects the 'elaboration' and 'organisation' strategies in the MSLQ framework. Elaboration was evident when students reported using the CD-ROM to understand the topics covered in the course. Also, whilst using the CD-ROM, students reported that the information on the CD-ROM served not only to increase understanding but also to clarify information they studied in the other course material. This clarification of information could be related to the 'organisation' strategy in the MSLQ framework, since this process entails forging and establishing links between old and new information. However, for students these processes were heavily intertwined, often being mentioned in unison, which led to this strategy being identified as a Knowledge Focused strategy rather distinct 'elaboration' and 'organisation' strategies.

A notable difference between the CD-ROM and traditional strategies was that the reports of students did not include behaviour linked to the 'rehearsal' or 'critical

thinking' strategies in the MSLQ framework. Rehearsal is often associated with simple tasks and takes the form of rote learning, this is unlikely to have been a useful strategy for the study of the CD-ROM. The lack of critical thinking arising from using the CD-ROM could be attributable to the subject matter of the course: it is factual in content and greater emphasis is place on the acquisition of knowledge.

Another difference was the focus students placed on notetaking, or rather why, in most cases, they made little-to-no notes from the CD-ROM. In the MSLQ framework, notetaking is seen as an activity linked to the elaboration strategy. However, as discussed earlier in this chapter, the reports of students indicated that notetaking, in terms of the CD-ROM, was quite distinct from the internal processes associated with the Knowledge Focused strategy and was recognised as a separate strategy in the computer-based framework of strategies.

The final strategy included in the computer-based framework is Self-Testing, which, to some degree reflects the monitoring behaviour associated with the 'metacognitive' strategy in the MSLQ framework. However, the metacognitive strategy included in the MSLQ framework, in part, emerged from the 'comprehension monitoring' strategy included in the Weinstein and Mayer (1985) strategy taxonomy upon which the MSLQ is based. The Self-Testing strategy is almost identical to Weinstein and Mayer's conceptualisation of the 'comprehension monitoring' strategy.

In terms of ***Resource Management*** strategies, the MSLQ framework lists four components for this class of strategy that, essentially, deals with how students manage and adapt their study time and environment to the demands of the learning task.

- *Time-management* - refers to how students schedule and regulate their time for the learning task in question.

- *Study Environment* - refers to the extent to which students work in a study environment that avoids distraction.

- *Effort Regulation* - refers to the students' ability to control their effort and attention when presented with distractions or uninteresting aspects of the learning task.

- *Support of others* - refers to what extent students seek support when they come across a difficult aspect of the learning task. This component is measured by two strategies *Peer Learning*, the help they seek from fellow students, and *Help Seeking*, whether they seek assistance from tutors and other resources.

In the three CD-ROM related studies, there was also evidence of time management and effort regulation but the MSLQ strategies did not account for this behaviour. The four strategies proposed to account for this class of strategy when it came to using the CD-ROM were specific to the use of the CD-ROM as a learning tool rather than a broader learning experience (i.e. texts, lectures and tutorials) traditionally associated with Resource Management strategies. Therefore, this class of strategic of behaviour was termed Tool Management, referring specifically to the management of time and effort spent with the CD-ROM.

Time-management was the only strategy to have characteristics in common with the four CD-ROM strategies in the Tool Management class. In the MSLQ framework the strategy 'study environment' refers to setting up of an environment that is conducive to study. A notable difference between the CD-ROM and traditional strategies in this class was not so much management of the environment in which learning with the CD-ROM took place, i.e. a dedicated working space, but rather a management of the learning environment. That is, most of the Tool Management strategies were characterised by a

cost-assessment exercise that was performed in relation to either the content of the CD-ROM or the use of its features such as the tools and instructions.

Another notable difference was the lack of help-seeking or peer-learning behaviour when using the CD-ROM. Only one student in Study IV reported studying the CD-ROM with fellow students and even then the student reported finding individual study more useful and productive. The lack of these behaviours may be due to the particular context of the course and indicates that either very few opportunities on the course arise where students feel the need for help and support or the students do not often seek help. The latter explanation would appear more likely considering a number of students reported having problems using the CD-ROM which they did nothing about in both Study II and III. Another important factor of their study to consider is that OU study is such that student are separated from both tutors and peers for the majority of their study time linked to the course.

8.4. Summary

This chapter discussed the findings of the research programme in view of the two research questions associated with this thesis. The first of these asked – what are the computer-based learning strategies of students. This chapter outlined a framework of ten strategies implicated in the study and use of the Human Brain CD-ROM. It further qualified how this framework addressed issues associated with past research that has examined computer-based learning strategies. That is, the framework presented a range of strategies covering the full use of the CD-ROM and examined these strategies in the real context of students studying a CAL system as part of a course.

The second part of the chapter addressed the second research question which sought to investigate the extent to the strategies in the framework differed from traditional strategies. The outcome of this examination was that although the computer-based and traditional strategies could be grouped into the same classes of strategies, i.e. motivation, cognitive and resource/tool management; the component strategies of these classes were different between the traditional and computer-based learning contexts.

The next chapter, the final one of this thesis, draws on these findings to conclude the overall research associated with this thesis.

Chapter 9

CONCLUSION

9.1. Introduction

This final chapter examines the achievements and limitations of the work associated with the thesis. It also examines the contributions of the work for educators, designers and students. The chapter ends with a number of proposals for future work.

9.2 Achievements of this thesis

The research described in this thesis is concerned with two issues: the computer-based learning strategies of students and the manner in which these strategies differ from traditional conceptions of learning strategies. There are a number of achievements associated with this thesis:

- A review of literature review of university learning in term of styles and strategies that included a comparison of instruments and measures that have previously been used to examine the traditional learning strategies of students.
- A critical review of previous research that examined the computer-based learning strategies of students and identified a series of issues associated with this research. These issues have been considered and addressed in the planning of this thesis.
- Formulation of a mixed-methodology research programme to investigate the computer-based learning strategies of students. On completion, this programme collected data on the learning experiences of approximately 500 students. The programme also involved the testing, for the first time, of the Motivated Strategies for Learning Questionnaire (MSLQ) on a sample of distance students studying in the UK. The programme also led to the first ever development and testing of a questionnaire that measured the computer-based learning strategies of students.

- The proposal of a novel framework of computer-based learning strategies incorporating both motivational, cognitive and tool management strategies that could contribute to the work of system evaluators, designers and educators.
- An examination of the extent to which these strategies differ from traditional conceptions of learning strategies.

The research process associated with this thesis began with an extensive review of the ways in which students' learning in the context of university study has developed over the last century. The outcome of this review was the identification of two shifts that have occurred in the way in which students learning has been conceptualised: from cognitive style to learning style and, most recently, from learning style to learning strategies. The review identified a general move away from classifying learners into particular groups, associated with conceptualisations of learning in terms of style, towards classifying the learning behaviour, the learning strategies, of an individual student.

This review also examined previous research that has explored the computer-based learning strategies of students. Studies of this phenomenon have been fairly limited in number and the review identified a series of limitations associated with this work. Previous examinations of computer-based learning strategies have often presented a limited set of strategies to account for the overall use of a computer-assisted learning (CAL) system (e.g. Lyman, 1998, Saunders, 1998). Other studies that have focused on particular aspects of using a CAL system, i.e. searching or navigation, have looked at these behaviours in isolation (e.g. Schroeder and Grabowski, 1995). They have given no consideration to the full extent of learning processes or behaviours associated with the use of a CAL system. A final limitation was a failure to consider the extent to which these strategies differed from conceptualisations of traditional learning strategies.

The purpose of examining students' computer-based learning strategies is simple and common to all learning strategy research – to understand the learning experience from the perspective of the student. Similarly, the purpose behind determining the extent to which computer-based strategies differ from traditional strategies is to provide a richer understanding of the learning experience of using a CAL system in the greater context of a course. With knowledge about the way in which students study and learn, instructors and designers can employ teaching strategies and corrective interventions that make the learning experience as successful and positive as possible for the student.

Another achievement of this thesis was the formulation of a research programme that combined both interview and questionnaire based data-collection methods. The learning experiences of approximately 500 students were examined over a series of four studies. The main outcomes of this thesis relating to computer-based learning emerged from data collected from 148 of those students. In all cases, the students were distance learners studying the course SD206: Biology, Brain and Behaviour with the Open University. The fact that this population was studying at a distance had a number of implications for the methodology adopted in the research programme. For instance, in the first study, Study I, the questionnaire used to establish the learning strategies of students using traditional course material had to be modified so that the phrasing of questions would be relevant to this distance setting. In later interview-based studies, Study II and IV, the majority of students were interviewed and observed using the CD-ROM in their own homes across both central and southern England, a small number of students were also interviewed by telephone.

In the first study, Study I, a traditional model of learning strategies, the framework associated with the MSLQ (Pintrich et al, 1989) was examined for its relevance to the study practices of a population of distance education students involved throughout the

research programme. One of the aims of the thesis was to compare the computer-based learning strategies of students to traditional conceptualisations of learning strategies. The purpose of this study was to ensure that the model chosen, originally developed in the USA on traditional college students, as is the case for most learning strategy models, was relevant to the population studied throughout the thesis. A review of traditional learning strategies measures and models was undertaken and the Motivated Strategies for Learning Questionnaire was selected as the most robust of these. The model differed from other models considered in that it considered students' strategies to differ dependent on the courses they studied as part of their degree. Other models, for instance the LASSI (Weinstein, Schulte and Palmer, 1987), consider learning strategies to differ amongst students in terms of how they approach the overall study of a degree. The outcome of this study was that the MSLQ was found to have both internal and external reliability in measuring the study practices of the distance education population. It was also the first time that the questionnaire had ever been modified and tested on sample of distance learning students in the United Kingdom.

Study II was the first study to examine the computer-based learning strategies of students. Eight students were interviewed about their use of the Human Brain CD-ROM. The findings of this early study indicated that although the strategies of students could be classed as motivational, cognitive and resource management, different strategies were adopted and used by students compared to those identified by the MSLQ.

Based on the findings of Study III, a questionnaire was designed to examine the learning strategies of a larger sample of students who had used the CD-ROM. There is no previous published report of a questionnaire either being developed, or tested, to examine the computer-based learning strategies of students. The questionnaire was

completed by 140 students on the SD206 course who used the CD-ROM. The findings from the questionnaire were analysed using Item and Factor Analysis. These analyses confirmed the existence of a series of motivational and cognitive strategies similar to those identified in Study II. However, the analyses threw into doubt the existence of different tool management strategies such as those proposed in Study II.

In the final study examining study practices linked to the CD-ROM, Study IV, twenty students were interviewed and observed using the CD-ROM. The reports of these students, alongside the findings from early studies in the research programme revealed ten strategies that comprised a novel framework of computer-based learning strategies.

This framework is potentially the most important outcome of this thesis. It addresses the criticisms identified with regards to previous research that has examined the computer based learning strategies of students. For example, it incorporates a broad set of strategies, ten in total that cover motivation, information processing and the management of available learning resources rather than being limited to, for example, navigation or search strategies. It also proposes a series of strategies that emerge from the experiences of a relatively large group of real learners engaged in the genuine study of a course, not a laboratory based exercise involving a small group of participants that has little relevance to their academic career.

Another outcome of this thesis was a comparison of these strategies to those proposed in the MSLQ framework. This comparison revealed that whilst individual strategies in the same classes shared some similarities, the computer-based learning strategies were on the whole distinct from the strategies proposed to account for the study of traditional course material.

With an understanding of what strategies are relevant to the computer-based learning experience of students using the CD-ROM, along with how these strategies differ from traditional learning strategies, another achievement of this thesis has been to consider these outcomes in terms of what implications they have for designers and educators. These implications are outlined in the next section of this chapter.

9.3. Relevance of the strategy model to our understanding of computer-assisted learning

Section 8.2 in the previous chapter outlined the computer-based learning strategies that emerged from three studies that examined students' use of a specific CD-ROM on a specific course. An issue raised by this framework is whether this proposal of strategies can extend beyond the use of the Human Brain CD-ROM for the course Biology, Brain and Behaviour to other computer assisted learning (CAL) programs.

In considering whether the model of learning strategies can extend beyond the CD-ROM, two questions have been considered:

- could the model assist in the evaluation of a learning experience involving a CAL component?
- could it provide a basis for improving the design of systems and their use in the teaching curriculum?

These questions reflect Mayer's (1988) assertion that any useful model of learning strategies should make a contribution towards improving learning.

Olgren (1998) has also outlined a series of benefits associated with learning strategies research. Olgren originally identified these benefits in terms of research involving distance education students studying traditional course material but they could also apply to the findings of the thesis. Firstly, such research can draw attention to the

quality of learning outcomes and the components involved in achieving that outcome. Secondly, learning strategies can also be used to assess why individual learners may not respond to the instructional events as intended. Finally, the conceptualisation of strategies provides a set of tangible components to be considered in aspects of course design intended to promote content learning, use of established skills and their development.

In relation to the motivational strategies included in the framework, if we examine the strategies proposed to account for why students started using the CD-ROM in the first place, i.e. Resource exploitation and Expectancy, we can extend their relevance beyond the CD-ROM to other computer assisted learning programs as shown in Table 9.1. The same is true for the Presentation Format strategy that accounts for students' motivation to continue using the CD-ROM. An important feature of Table 9.1. is an appreciation of differing levels of strategic behaviour as either high or low. This reflects the findings from Study III that even though students may be studying the same course and using the same system, they will vary in terms of the extent to which they adopt or demonstrate a particular strategy. Therefore, in Table 9.1 strategies are considered as either adopted to a great extent (high) or to a little extent (low) by students. The table also offers a series of responses or instructional approaches that can be taken by the educator and designer in response to high/low use of a strategy.

Table 9.1.: Extension of the SPOTLITE motivational strategies to other systems

Strategy Incidence	Characterised by	Instructional Response
Resource exploitation – high	Need to use all learning resources	Explicitly reinforce use of computer assisted learning material
Resource exploitation – low	Selective use of learning resources even if all are intended to contribute to the learning experience	Encourage use of all learning materials and ensure to students that it offers a pedagogical advantage
Expectancy – high	A number of expectations linked to what information will be on the system and how it will be presented	Explicit outline of what information is on the system and how it contributes to the learning experience of the course
Expectancy – low	Few expectations of what will be included in the system	Same as above but an actual demonstration of the system should also be considered
Presentation format – high	The system compares positively to other learning resources by making the material easier to understand, can be indication of dependency on the system	Encourage use of the system alongside the other course materials and demonstrate how computer-based and traditional media can be integrated
Presentation format – low	The system fails to make a contribution to their understanding of the domain	This could be a design related issue or could arise from students not having any real idea of what they are supposed to be using the system to achieve. Therefore, provide students with examples of how the system could help their learning of the domain.

This conceptualisation of cognitive strategies could also be argued to extend beyond the CD-ROM and cover a range of information processing activities including: cognitive or internal information processing often expressed in terms of abstract processes such as 'understanding' (represented in the Knowledge Focused strategy); a practical application of the information (represented in the Notetaking strategy); and a monitoring of what has been learnt (represented in the Self- Testing strategy). Like the motivational strategies, Table 9.2 outlines a high and low incidence of the Knowledge Focused and Notetaking strategies.

Table 9.2.: Extension of the SPOTLITE cognitive strategies to other systems

Strategy Incidence	Charaterised by	Instructional Response
Knowledge Focused - high	Extensive use of the system's content to understand and clarify concepts from other course material	An indication of the difficulty students are having learning the course content from other the course material. An examination is required of the course material and the difficulties it presents to students.
Knowledge Focused – low	Limited use of the system to understand and clarify concepts from the course material	Potentially a good sign if this is associated with positive reports about the other course material as this would indicate that the materials offer a positive and engaging learning experience. If this is associated with negative reports about the other course material then the students may be finding the course content too difficult to master or learn. Again an examination would be necessary of the course material to see what difficulties, if any, it presents to students.
Notetaking – high	A large quantity of notes made from the content of the system	Should be encouraged and reinforced with regards to the kinds of notes to make and what purpose the notes should serve
Notetaking - low	Little or no notes being made	Encourage notetaking, making explicit not only the kind of notes to make but also the general benefits of notetaking

Self-Testing is not included in this table because it has a series of components that mean, unlike the other cognitive strategies, the overall behaviour associated with this strategy cannot be categorised in terms of a high or low incidence. However, if we examine each of the four components associated with the Self-Testing strategy we can still make suggestions about how they might be useful to educators and designers.

The four components to the strategy included: (i) when the Objectives and QuickTest facilities were used; (ii) why they were used; and in the case of the QuickTest facility, (iii) what knowledge the items were used to test and, finally, (iv) what the students did with the feedback the system provided. Students differed with respect to when they used the Objectives and QuickTest facilities on the CD-ROM but there was no evidence that using the facilities after a section had been completed was more advantageous than

using the facilities purely for revision at the end of the course. The instructions for the system could therefore include an explicit instruction about when to use these types of facilities.

In considering the second component of the Self Testing strategy (why these facilities are used) we know that students used the QuickTest and Objectives facilities to gauge what they needed to learn or had learnt having gone through a section on the CD-ROM. In relation to the third component of the strategy (what knowledge the items were used to test), students largely reported that the QuickTest facility in particular was used to test what they had learnt across the different course material including the CD-ROM. These findings justify retaining the Objectives and QuickTest facilities in future redesigns of the CD-ROM and for their inclusion in other system designs. That is, they allow students to test their knowledge of their domain from a variety of resources and also they are can be easily accessed and provide an immediate indication of what has been learnt.

In terms of the fourth component of the strategy, we know that when students responded incorrectly to a question they either went through the available responses until the correct answer was revealed or that they went back through the content of the CD-ROM to establish the correct response. A suggestion here for designers would be to indicate why the correct response answered the question and to provide an optional link back to where that information was displayed in the content of the system.

The Tool Management strategies could also extend beyond CD-ROM and provide the designer/educator with a basis for examining or highlighting how students interact with and use a computer based learning system. One of the major considerations to bear in mind is the cost-assessment exercise that is linked to a number of aspects of using the CD-ROM, particularly the use of tools, navigation and the use of support facilities such

as instructions and record saving devices. Added-extras, such as the tools and the use of the support facilities are often not used because of assessments made by students that either they cannot use them or that they will have no benefit to learning the course content. Explicit instructions about how they could be used and also a statement of why they would be useful could overcome this. The Usage strategy is also important it that it can essentially be considered a gauge of how well students adhere to instructions about how long the system should be used and how it should be used alongside other course material.

9.4. Implications for students

There are two potential implications arising from the outcomes of this thesis that relate to students. Firstly, awareness by designers and educators of the computer-based strategies used by students should have a positive impact on the design and integration of CAL systems into the curriculum. Therefore, the learning experience of students involving CAL systems should be enhanced.

The second implication for students is that a rationalisation of computer-based behaviour in terms of strategies, provides a basis for giving students feedback about their learning experience. This has been adopted by Pintrich et al (1989) in their development of the MSLQ, where students asked to complete the questionnaire were given their own score for each strategy in relation to the scores of other students on the course. Whilst this type of feedback may not have a direct influence on the learning processes of students it can have an affective impact. It can lessen the feelings of inadequacy and, in the case of distance education students, provide insight into the experience of other students' approaches to study. These feelings were reported by a number of students in the interviews about the CD-ROM. Typically, students reported that when they started the technology they wanted to know how their fellow students

were using the CD-ROM. However, few, if any, actually spoke to other students on the course about the CD-ROM and its integration into the study of the course or its use as part of the course materials. Thus, insight into the strategies being used by other students could overcome these types of anxiety.

The next sections of this chapter examine some of the limitations associated with this thesis and also discuss plans for future work and research.

9.5 Limitations

The strategies identified in this thesis emerged from commonalities in the reports of students, a similar process to that used by Zimmerman (1986, 1989; Zimmerman and Pons, 1986) to establish the strategies of students learning with traditional teaching tool and methods. Cohen and Manion (1984) also suggest using interviews as a means of validating data collected from other research methods, such as questionnaires. However, one of the limitations associated with survey research of this kind is integrity of the data, i.e. whether the responses of the research participants are valid and therefore reflect the phenomenon being investigated.

Throughout the research programme there was a consistent identification of similar motivational and information processing behaviour in the interviews carried out in Study II and IV and the questionnaire used in Study III. However, resource/tool management strategies failed to emerge in a consistent fashion across these studies. This inconsistency initially came to light when the findings of the SPOTLITE questionnaire developed in Study III were analysed and failed to produce strategies or constructs that resembled the strategies found in Study II. Also, comparison of these constructs revealed that they gave little insight into strategic behaviour and more insight into the opinions of students about particular features of the CD-ROM. This could account for a failure to elicit information about the students' tool management strategies in the

interviews carried out in Study II and the questionnaire designed in Study III. Study IV attempted to rectify this issue by concentrating on what students did to support their time and effort spent using the CD-ROM. This revealed four novel tool management strategies but future work is needed to verify the existence of these strategies with any certainty.

Another issue to consider is the extent to which these strategies realistically extend beyond the CD-ROM to other CAL systems. The previous sections outlined how these strategies could be used in the examination of other CAL systems but again this requires further investigation. The next section examines this and other avenues as planned work for the future.

9.6. Plans for future research

A key question that future research should address is to determine to what extent the strategies that emerge from this thesis are relevant to computer-assisted learning programs other than the Human Brain CD-ROM. If future research indicates that the model can be substantiated in other domains, then another research direction would be to explore the way in which students differ in terms of the extent to which they use these strategies.

The SPOTLITE questionnaire designed and used in Study III proved, to some extent, to provide a sensitive measure of students' computer-based learning strategies. It seemed to adequately measure the motivational and cognitive computer-based strategies of students but the questionnaire needs to be validated in view of the final framework and especially the uncertainty surrounding the tool management strategies.

With the development of a valid measure of computer-based learning strategies, future work should also endeavour to identify the relationship between the strategies students

use when learning with traditional course material and computer based learning environments. The findings of this thesis indicate that students use a series of motivational, cognitive and resource management strategies in the study of both traditional and computer-based learning materials. In this thesis these are considered broad classes of strategies. However, the strategies that fall into these classes differ between computer-based and traditional learning materials. Further research is needed to determine what impact these differences have, not only on the learning experience of students, but also their learning outcome. This is an important avenue of investigation because CAL is used increasingly to support or supplement traditional teaching. If our students are faced with systems that require strategic behaviour that is markedly different from that they are used to we need to know whether this will have an impact on their success using the system and learning the domain.

9.7. Summary

This chapter has outlined a series of achievements of this thesis; the potential of its outcomes for the work of educators, CAL system designers and the learning experience of students. The chapter has also addressed some of the limitations of the work and indicated the potential in continuing research associated with this thesis.

Chapter 2 highlighted the following two recommendations from the Dearing Report (Dearing, 1997) on Higher Education in United Kingdom:

> *Recommendation 8: We recommend that, with immediate effect, all institutions of higher education give high priority to developing and implementing learning and teaching strategies which focus on the promotion of students' learning. (Chapter 8, p116)*

> *Recommendation 9: We recommend that all institutions should...review the changing role of staff as a result of communications and information technology, and ensure that staff and students receive appropriate training and support to enable them to realise its full potential (Chapter 8, p121)*

These recommendations are made to those who hold the key to students' success in higher education. The report recognises the importance of understanding the complexity

of students' learning and the potential for information and communications technology in the modern university curriculum. This thesis embraces both principles but more importantly is intended to make a contribution to the on ongoing effort of educators and designers to allow students to realise the full potential of their abilities.

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APPENDICES

APPENDIX A: Original Motivated Strategies for Learning Questionnaire

Part A. Motivation

The following questions ask about your motivation for and attitudes about this class. **Remember there are no right or wrong answers, just answer as accurately as possible.** Use the scale below to answer the questions. If you think the statement is very true of you, circle 7; if a statement is not at all true of you, circle 1. If the statement if more or less true of you, find the number between 1 and 7 that best describes you.

1 not at all true of me — 2 — 3 — 4 — 5 — 6 — 7 very true of me

1.	In a class like this, I prefer course material that really challenges me so I can learn new things.	1	2	3	4	5	6	7
2.	If I study in appropriate ways, then I will be able to learn the material in this course.	1	2	3	4	5	6	7
3.	When I take a test I think about how poorly I am doing compared with other students.	1	2	3	4	5	6	7
4.	I think I will be able to use what I learn on in this course on other courses.	1	2	3	4	5	6	7
5.	I believe I will receive an excellent grade for this class.	1	2	3	4	5	6	7
6.	I'm certain I can understand the most difficult material presented in the readings for this course.	1	2	3	4	5	6	7
7.	Getting a good grade in this class is the most satisfying thing for me right now.	1	2	3	4	5	6	7
8.	When I take a test I think about items on other parts of the test I can answer.	1	2	3	4	5	6	7
9.	It is my own fault if I don't learn the material in this course.	1	2	3	4	5	6	7
10.	It is important for me to learn the material in this class	1	2	3	4	5	6	7
11.	The most important thing for me right now is improving my overall grade point average, so my main concern in this class is getting a good grade.	1	2	3	4	5	6	7
12.	I'm confident I can understand the basic concepts taught on this course	1	2	3	4	5	6	7
13.	If I can, I want to get better grades on this course than most of the other students.	1	2	3	4	5	6	7
14.	When I complete tests I think of the consequences of failing.	1	2	3	4	5	6	7
15.	I'm confident I can understand the most complex material presented by the instructor in this course.	1	2	3	4	5	6	7
16.	In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.	1	2	3	4	5	6	7
17.	I am very interested in the content area of this course.	1	2	3	4	5	6	7
18.	If I try hard enough, then I will understand the course material.	1	2	3	4	5	6	7
19.	I have an uneasy, upset feeling when I take an exam.	1	2	3	4	5	6	7
20.	I'm confident I can do an excellent job on the assignments and tests in this course	1	2	3	4	5	6	7
21.	I can expect to do well on in this class.	1	2	3	4	5	6	7
22.	The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible.	1	2	3	4	5	6	7

		not at all true of me						very true of me
23.	I think the course material in this class is useful for me to learn.	1	2	3	4	5	6	7
24.	When I have the opportunity in this class, I choose course assignments that I can learn from even if they don't guarantee a good grade.	1	2	3	4	5	6	7
25.	If I don't understand the course material, it is because I didn't try hard enough.	1	2	3	4	5	6	7
26.	I like the subject matter of this course	1	2	3	4	5	6	7
27.	Understanding the subject matter of this course is very important to me.	1	2	3	4	5	6	7
28.	I feel my heart beating fast when I take an exam.	1	2	3	4	5	6	7
29.	I am certain I can master the skills being taught in this class.	1	2	3	4	5	6	7
30.	I want to do well in this class because it is important to show my ability to my family, friends, employer, or others.	1	2	3	4	5	6	7
31.	Considering the difficulty of this course, the tutor, and my skills, I think I will do well on this course.	1	2	3	4	5	6	7

Part B. Learning Strategies

The following questions ask about your learning strategies and study skills for this class. **Again, there are no right or wrong answers. Answer the questions about how you study in this course as accurately as possible.** If you think the statement is very true of you, circle 7; if a statement is not at all true of you, circle 1. If the statement if more or less true of you, find the number between 1 and 7 that best describes you.

1 not at all true of me 2 3 4 5 6 7 very true of me

32.	When I study the readings for this course, I outline the material to help me organise my thoughts.	1	2	3	4	5	6	7
33.	During class time I often miss important points because I'm thinking of other things.	1	2	3	4	5	6	7
34.	When studying for this course, I often try to explain the material to a classmate or friend.	1	2	3	4	5	6	7
35.	I usually study in a place where I can concentrate on my course work.	1	2	3	4	5	6	7
36.	When reading for this course, I make up questions to help focus my reading.	1	2	3	4	5	6	7
37.	I often feel so lazy or bored when I study for this class that I give up before I finish what I planned to do.	1	2	3	4	5	6	7
38.	I often find myself questioning things I hear or read in this course to decide if I find them convincing.	1	2	3	4	5	6	7
39.	When I study for this class, I practice saying the material to myself over and over.	1	2	3	4	5	6	7
40.	Even if I have trouble learning the material in this class, I try to do the work on my own, without help from anyone.	1	2	3	4	5	6	7
41.	When I become confused about something I'm reading for this class, I go back and try to figure it out.	1	2	3	4	5	6	7
42.	When I study for this course, I go through the readings and my notes and try to find the most important ideas.	1	2	3	4	5	6	7

		not at all true of me						very true of me
43.	I make good use of my study time for this course.	1	2	3	4	5	6	7
44.	If course readings are difficult to understand, I change the way I read the material.	1	2	3	4	5	6	7
45.	I try to work with other students from this class to complete the course assignments.	1	2	3	4	5	6	7
46.	When studying for this course, I read my class notes and the course readings over and over gain.	1	2	3	4	5	6	7
47.	When a theory, interpretation, or conclusion is presented in class, I try to decide if there is good supporting evidence.	1	2	3	4	5	6	7
48.	I work hard to do well in this class even if I don't like what we are doing	1	2	3	4	5	6	7
49.	I make simple charts, diagrams, or tables to help me organise course material.	1	2	3	4	5	6	7
50.	When studying for this course, I often set aside time to discuss the course material with a group of students from the class.	1	2	3	4	5	6	7
51.	I treat the course material as a starting point and try to develop my own ideas about it.	1	2	3	4	5	6	7
52.	I find it hard to stick to a study schedule.	1	2	3	4	5	6	7
53.	When I study for this class, I pull together information from different sources, such as lectures, readings and discussions.	1	2	3	4	5	6	7
54.	Before I study new course material thoroughly, I often skim it to see how it is organised.	1	2	3	4	5	6	7
55.	I ask myself questions to make sure I understand the material I have been studying in class.	1	2	3	4	5	6	7
56.	I try to change the way I study in order to fit the course requirements and the instructor's teaching style.	1	2	3	4	5	6	7
57.	I often find that I have been reading for this class but don't know what it was all about.	1	2	3	4	5	6	7
58.	I ask my tutor the instructor to clarify concepts on the course I don't understand well.	1	2	3	4	5	6	7
59.	I memorise key words to remind me of important concepts in this class	1	2	3	4	5	6	7
60.	When course work is difficult, I give up or only study the easy parts.	1	2	3	4	5	6	7
61.	I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying.	1	2	3	4	5	6	7
62.	I try to relate ideas in this subject to those from other courses whenever possible.	1	2	3	4	5	6	7
63.	When I study for this course, I go over my notes and make an outline of important concepts.	1	2	3	4	5	6	7
64.	When reading for this class, I try to relate the material to what I already know.	1	2	3	4	5	6	7
65.	I have a regular place set aside for studying.	1	2	3	4	5	6	7

		not at all true of me						very true of me
66.	I try to play around with ideas of my own related to what I am learning in this course.	1	2	3	4	5	6	7
67.	When I study for this course, I write brief summaries of the main ideas and concepts.	1	2	3	4	5	6	7
68.	When I can't understand the material in this course, I ask another student on the course for help.	1	2	3	4	5	6	7
69.	I try to understand the material in this class by making connections between the readings and the concepts from lectures.	1	2	3	4	5	6	7
70.	I make sure I keep up with the weekly readings and assignments for this course.	1	2	3	4	5	6	7
71.	Whenever I read or hear an assertion or conclusion in this class, I think about possible alternatives.	1	2	3	4	5	6	7
72.	I make lists of important terms for this course and memorise the lists.	1	2	3	4	5	6	7
73.	I attend this class regularly.	1	2	3	4	5	6	7
74.	Even when course materials are dull and uninteresting, I manage to keep working until I finish.	1	2	3	4	5	6	7
75.	I try to identify students in this class whom I can ask for help if necessary.	1	2	3	4	5	6	7
76.	When studying for this course I try to determine which concepts I don't understand well.	1	2	3	4	5	6	7
77.	I often find that I don't spend very much time on this course because of other activities.	1	2	3	4	5	6	7
78.	When I study for this class, I set goals for myself in order to direct my activities in each study period.	1	2	3	4	5	6	7
79.	If I get confused taking notes in class, I make sure I sort it out afterwards.	1	2	3	4	5	6	7
80.	I rarely find time to review my notes or readings before an exam.	1	2	3	4	5	6	7
81.	I try to apply ideas from course readings in other class activities such as lecture and discussion.	1	2	3	4	5	6	7

APPENDIX B: Study I – Questionnaire 1

STUDY RELATED INFORMATION

1. How much has SD206 required you to: *(Circle one only in each row)*		Not at all			Very
a)	Memorise facts/concepts	1	2	3	4
b)	Understand concepts/ideas	1	2	3	4
c)	Apply your learning to your own experience/life/job	1	2	3	4
d)	Analyse data/descriptions/arguments	1	2	3	4
e)	Synthesise and put together ideas	1	2	3	4
f)	Evaluate using your judgement/values	1	2	3	4

2. What were your reasons for taking this course? *(please TICK one or more of the options below)*

a) I wanted a 60 point course ❑
b) As part of my degree profile ❑
c) To develop my subject interest ❑
d) To improve my career prospects ❑
e) Preparation for further study ❑
f) For general interest ❑

3. How many hours **on average** did you spend in a typical week on the SD206 course? *(please TICK one)*

a) Less than two hours ❑
b) Two to six ❑
c) Seven to ten ❑
d) Eleven to fifteen ❑
e) More than fifteen ❑

4. Have you, or do you intend to, make use of the 'The Human Brain' CD-ROM which is available as an 'optional' resource material for SD206? *(please TICK one)*

Yes ❑
No ❑

if you answered 'No' to the above question please indicate the *main* reason why (please *TICK* one)

I do not have access to a computer with a CD-ROM drive ❑
I feel it would take too much time to learn how to use the CD-ROM ❑
I prefer to study from books, video etc. ❑
Other reason (please give details below) ❑

THE MOTIVATED STRATEGIES FOR LEARNING QUESTIONNAIRE

Part A. Motivation

The following questions ask about your motivation for and attitudes about the SD206 course. **Remember there are no right or wrong answers, just answer as accurately as possible.** Use the scale below to answer the questions. If you think the statement is very true of you, circle 7; if a statement is not at all true of you, circle 1. If the statement if more or less true of you, find the number between 1 and 7 that best describes you.

1	2	3	4	5	6	7
not at all true of me						very true of me

1.	I prefer course material for SD206 that really challenges me so I can learn new things.	1	2	3	4	5	6	7
2.	If I study in appropriate ways, then I will be able to learn the material for SD206.	1	2	3	4	5	6	7
3.	When I have completed an assessment I have thought about how poorly I was doing compared with other students.	1	2	3	4	5	6	7
4.	I think I will be able to use what I learn on SD206 in other courses.	1	2	3	4	5	6	7
5.	I believe I will receive an excellent grade for SD206.	1	2	3	4	5	6	7
6.	I'm certain I can understand the most difficult material on SD206.	1	2	3	4	5	6	7
7.	Getting a good grade for SD206 is the most satisfying thing for me right now.	1	2	3	4	5	6	7
8.	When I complete an assessment I think about the parts I can't answer.	1	2	3	4	5	6	7
9.	It is my own fault if I don't learn the material for SD206.	1	2	3	4	5	6	7
10.	It is important for me to learn the material for SD206.	1	2	3	4	5	6	7
11.	The most important thing for me right now is improving my overall average, so my main concern in completing SD206 is getting a good grade.	1	2	3	4	5	6	7
12	I'm confident I can understand the basic concepts taught on SD206.	1	2	3	4	5	6	7
13.	If I can, I want to get better grades on SD206 than most of the other students.	1	2	3	4	5	6	7
14.	When I complete assessments I think of the consequences of failing	1	2	3	4	5	6	7
15.	I'm confident I can understand the most complex material presented on SD206.	1	2	3	4	5	6	7
16.	I prefer course material for SD206 that arouses my curiosity, even if it is difficult to learn.	1	2	3	4	5	6	7
17.	I am very interested in the content area of SD206.	1	2	3	4	5	6	7
18.	If I try hard enough, then I will understand the course material for SD206.	1	2	3	4	5	6	7
19.	I have an uneasy, upset feeling when I take an exam.	1	2	3	4	5	6	7
20.	I'm confident I can do an excellent job on the assessments for SD206.	1	2	3	4	5	6	7
21.	I can expect to do well on SD206.	1	2	3	4	5	6	7
22.	The most satisfying thing for me with regards to SD206 is trying to understand the content as thoroughly as possible.	1	2	3	4	5	6	7

		not at all true of me						very true of me
23.	I think the course material for SD206 is useful for me to learn.	1	2	3	4	5	6	7
24.	When I have the opportunity in SD206, I choose course assignments that I can learn from even if they don't guarantee a good grade.	1	2	3	4	5	6	7
25.	If I don't understand the course material for SD206, it is because I didn't try hard enough.	1	2	3	4	5	6	7
26.	I like the subject matter of SD206.	1	2	3	4	5	6	7
27.	Understanding the subject matter of for SD206 is very important to me.	1	2	3	4	5	6	7
28.	I feel my heart beating fast when I take an exam.	1	2	3	4	5	6	7
29.	I am certain I can master the skills being taught on SD206.	1	2	3	4	5	6	7
30.	I want to do well on SD206 because it is important to show my ability to my family, friends, employer, or others.	1	2	3	4	5	6	7
31.	Considering the difficulty of SD206, the tutor, and my skills, I think I will do well on this course.	1	2	3	4	5	6	7

Part B. Learning Strategies

The following questions ask about your learning strategies and study skills for the SD206 course. **Again, there are no right or wrong answers. Answer the questions about how you study in this course as accurately as possible.** If you think the statement is very true of you, circle 7; if a statement is not at all true of you, circle 1. If the statement if more or less true of you, find the number between 1 and 7 that best describes you.

1 not at all true of me 2 3 4 5 6 7 very true of me

32.	When I study the readings for SD206, I outline the material to help me organise my thoughts.	1	2	3	4	5	6	7
33.	Whilst studying SD206 course material I often miss important points because I'm thinking of other things.	1	2	3	4	5	6	7
34.	When studying for SD206, I often try to explain the material to another student on the course or a friend.	1	2	3	4	5	6	7
35.	I usually study for SD206 in a place where I can concentrate on my course work.	1	2	3	4	5	6	7
36.	When reading for SD206, I make up questions to help focus my reading.	1	2	3	4	5	6	7
37.	I often feel so lazy or bored when I study the SD206 course material that I give up before I finish what I planned to do.	1	2	3	4	5	6	7
38.	I often find myself questioning things I hear or read on SD206 to decide if I find them convincing.	1	2	3	4	5	6	7
39.	When I study for SD206, I practice saying the material to myself over and over.	1	2	3	4	5	6	7
40.	Even if I have trouble learning the material for SD206, I try to do the work on my own, without help from anyone.	1	2	3	4	5	6	7
41.	When I become confused about something I'm studying for SD206, I go back and try to figure it out.	1	2	3	4	5	6	7
42.	When I study for SD206, I go through the readings and my notes and try to find the most important ideas.	1	2	3	4	5	6	7

		not at all true of me						very true of me
43.	I make good use of my study time for the SD206 course.	1	2	3	4	5	6	7
44.	If SD206 course materials are difficult to understand, I change the way I read the material.	1	2	3	4	5	6	7
45.	I try to work with other SD206 students to complete the course assignments.	1	2	3	4	5	6	7
46.	When studying for SD206, I read my notes and the course readings over and over gain.	1	2	3	4	5	6	7
47.	When a theory, interpretation, or conclusion is presented on SD206, I try to decide if there is good supporting evidence.	1	2	3	4	5	6	7
48.	I work hard to do well on the SD206 course even if I don't like the material set to study.	1	2	3	4	5	6	7
49.	I make simple charts, diagrams, or tables to help me organise SD206 material.	1	2	3	4	5	6	7
50.	When studying for SD206, I often set aside time to discuss the course material with a group of students from the course.	1	2	3	4	5	6	7
51.	I treat SD206 course material as a starting point and try to develop my own ideas about it.	1	2	3	4	5	6	7
52.	I find it hard to stick to a study schedule for SD206.	1	2	3	4	5	6	7
53.	When I study for SD206, I pull together information from different sources, such as the tutorials, the course materials and discussions with others.	1	2	3	4	5	6	7
54.	Before I study new SD206 material thoroughly, I often skim it to see how it is organised.	1	2	3	4	5	6	7
55.	I ask myself questions to make sure I understand the material I have been studying on SD206.	1	2	3	4	5	6	7
56.	I try to change the way I study in order to fit SD206 course requirements and the way in which information is presented.	1	2	3	4	5	6	7
57.	I often find that I have been reading for SD206 but don't know what it was all about.	1	2	3	4	5	6	7
58.	I ask my tutor for SD206 to clarify concepts on the course I don't understand well.	1	2	3	4	5	6	7
59.	I memorise key words to remind me of important concepts in SD206.	1	2	3	4	5	6	7
60.	When SD206 course work is difficult, I give up or only study the easy parts.	1	2	3	4	5	6	7
61.	On SD206 I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying.	1	2	3	4	5	6	7
62.	I try to relate ideas from SD206 to those from other courses whenever possible.	1	2	3	4	5	6	7
63.	When I study for SD206, I go over my notes and make an outline of important concepts.	1	2	3	4	5	6	7
64.	When reading for SD206, I try to relate the material to what I already know.	1	2	3	4	5	6	7
65.	I have a regular place set aside for studying SD206 material.	1	2	3	4	5	6	7

		not at all true of me						very true of me
66.	I try to play around with ideas of my own related to what I am learning on SD206.	1	2	3	4	5	6	7
67.	When I study for SD206, I write brief summaries of the main ideas and concepts.	1	2	3	4	5	6	7
68.	When I can't understand SD206 course material, I ask another student on the course for help.	1	2	3	4	5	6	7
69.	I try to understand the material for SD206 by making connections between the readings and the concepts from tutorials.	1	2	3	4	5	6	7
70.	I make sure I keep up with the weekly readings and assignments for SD206.	1	2	3	4	5	6	7
71.	Whenever I read or hear an assertion or conclusion on SD206, I think about possible alternatives.	1	2	3	4	5	6	7
72.	I make lists of important terms in the SD206 and memorise the lists.	1	2	3	4	5	6	7
73.	I attend tutorials for SD206 regularly.	1	2	3	4	5	6	7
74.	Even when SD206 course materials are dull and uninteresting, I manage to keep working until I finish.	1	2	3	4	5	6	7
75.	I try to identify students studying SD206 whom I can ask for help if necessary.	1	2	3	4	5	6	7
76.	When studying for SD206 I try to determine which concepts I don't understand well.	1	2	3	4	5	6	7
77.	I often find that I don't spend very much time on the SD206 course material because of other activities.	1	2	3	4	5	6	7
78.	When I study for SD206, I set goals for myself in order to direct my activities in each study period.	1	2	3	4	5	6	7
79.	If I get confused taking notes in SD206 tutorials, I make sure I sort it out afterwards.	1	2	3	4	5	6	7
80.	I rarely find time to review my notes or readings before an exam.	1	2	3	4	5	6	7
81.	I try to apply ideas from course readings to other SD206 activities.	1	2	3	4	5	6	7

This research is part of an ongoing project, please tick the box below if you would **not** like to be contacted again.

APPENDIX C: Study I – Questionnaire 2

THE MOTIVATED STRATEGIES FOR LEARNING QUESTIONNAIRE

Part A. Motivation

The following questions ask about your motivation for and attitudes about the SD206 course. **Remember there are no right or wrong answers, just answer as accurately as possible.** Use the scale below to answer the questions. If you think the statement is very true of you, circle 7; if a statement is not at all true of you, circle 1. If the statement if more or less true of you, find the number between 1 and 7 that best describes you.

1 not at all true of me — 2 — 3 — 4 — 5 — 6 — 7 very true of me

1.	I prefer course material for SD206 that really challenges me so I can learn new things.	1	2	3	4	5	6	7
2.	If I study in appropriate ways, then I will be able to learn the material for SD206.	1	2	3	4	5	6	7
3.	When I have completed an assessment I have thought about how poorly I was doing compared with other students.	1	2	3	4	5	6	7
4.	I think I will be able to use what I learn on SD206 in other courses.	1	2	3	4	5	6	7
5.	I believe I will receive an excellent grade for SD206.	1	2	3	4	5	6	7
6.	I'm certain I can understand the most difficult material on SD206.	1	2	3	4	5	6	7
7.	Getting a good grade for SD206 is the most satisfying thing for me right now.	1	2	3	4	5	6	7
8.	When I complete an assessment I think about the parts I can't answer.	1	2	3	4	5	6	7
9.	It is my own fault if I don't learn the material for SD206.	1	2	3	4	5	6	7
10.	It is important for me to learn the material for SD206.	1	2	3	4	5	6	7
11.	The most important thing for me right now is improving my overall average, so my main concern in completing SD206 is getting a good grade.	1	2	3	4	5	6	7
12.	I'm confident I can understand the basic concepts taught on SD206.	1	2	3	4	5	6	7
13.	If I can, I want to get better grades on SD206 than most of the other students.	1	2	3	4	5	6	7
14.	When I complete assessments I think of the consequences of failing	1	2	3	4	5	6	7
15.	I'm confident I can understand the most complex material presented on SD206.	1	2	3	4	5	6	7
16.	I prefer course material for SD206 that arouses my curiosity, even if it is difficult to learn.	1	2	3	4	5	6	7
17.	I am very interested in the content area of SD206.	1	2	3	4	5	6	7

not at all very true

		not at all true of me						very true of me
18.	If I try hard enough, then I will understand the course material for SD206.	1	2	3	4	5	6	7
19.	I have an uneasy, upset feeling when I take an exam.	1	2	3	4	5	6	7
20.	I'm confident I can do an excellent job on the assessments for SD206.	1	2	3	4	5	6	7
21.	I can expect to do well on SD206.	1	2	3	4	5	6	7
22.	The most satisfying thing for me with regards to SD206 is trying to understand the content as thoroughly as possible.	1	2	3	4	5	6	7
23.	I think the course material for SD206 is useful for me to learn.	1	2	3	4	5	6	7
24.	When I have the opportunity in SD206, I choose course assignments that I can learn from even if they don't guarantee a good grade.	1	2	3	4	5	6	7
25.	If I don't understand the course material for SD206, it is because I didn't try hard enough.	1	2	3	4	5	6	7
26.	I like the subject matter of SD206.	1	2	3	4	5	6	7
27.	Understanding the subject matter of for SD206 is very important to me.	1	2	3	4	5	6	7
28.	I feel my heart beating fast when I take an exam.	1	2	3	4	5	6	7
29.	I am certain I can master the skills being taught on SD206.	1	2	3	4	5	6	7
30.	I want to do well on SD206 because it is important to show my ability to my family, friends, employer, or others.	1	2	3	4	5	6	7
31.	Considering the difficulty of SD206, the tutor, and my skills, I think I will do well on this course.	1	2	3	4	5	6	7

Part B. Learning Strategies

The following questions ask about your learning strategies and study skills for the SD206 course. **Again, there are no right or wrong answers. Answer the questions about how you study in this course as accurately as possible.** If you think the statement is very true of you, circle 7; if a statement is not at all true of you, circle 1. If the statement if more or less true of you, find the number between 1 and 7 that best describes you.

1	2	3	4	5	6	7
not at all true of me						very true of me

		not at all true of me						very true of me
32.	When I study the readings for SD206, I outline the material to help me organise my thoughts.	1	2	3	4	5	6	7
33.	Whilst studying SD206 course material I often miss important points because I'm thinking of other things.	1	2	3	4	5	6	7
34.	When studying for SD206, I often try to explain the material to another student on the course or a friend.	1	2	3	4	5	6	7
35.	I usually study for SD206 in a place where I can concentrate on my course work.	1	2	3	4	5	6	7
36.	When reading for SD206, I make up questions to help focus my reading.	1	2	3	4	5	6	7
37.	I often feel so lazy or bored when I study the SD206 course material that I give up before I finish what I planned to do.	1	2	3	4	5	6	7
38.	I often find myself questioning things I hear or read on SD206 to decide if I find them convincing.	1	2	3	4	5	6	7

		not at all true of me						very true of me
39.	When I study for SD206, I practice saying the material to myself over and over.	1	2	3	4	5	6	7
40.	Even if I have trouble learning the material for SD206, I try to do the work on my own, without help from anyone.	1	2	3	4	5	6	7
41.	When I become confused about something I'm studying for SD206, I go back and try to figure it out.	1	2	3	4	5	6	7
42.	When I study for SD206, I go through the readings and my notes and try to find the most important ideas.	1	2	3	4	5	6	7
43.	I make good use of my study time for the SD206 course.	1	2	3	4	5	6	7
44.	If SD206 course materials are difficult to understand, I change the way I read the material.	1	2	3	4	5	6	7
45.	I try to work with other SD206 students to complete the course assignments.	1	2	3	4	5	6	7
46.	When studying for SD206, I read my notes and the course readings over and over gain.	1	2	3	4	5	6	7
47.	When a theory, interpretation, or conclusion is presented on SD206, I try to decide if there is good supporting evidence.	1	2	3	4	5	6	7
48.	I work hard to do well on the SD206 course even if I don't like the material set to study.	1	2	3	4	5	6	7
49.	I make simple charts, diagrams, or tables to help me organise SD206 material.	1	2	3	4	5	6	7
50.	When studying for SD206, I often set aside time to discuss the course material with a group of students from the course.	1	2	3	4	5	6	7
51.	I treat SD206 course material as a starting point and try to develop my own ideas about it.	1	2	3	4	5	6	7
52.	I find it hard to stick to a study schedule for SD206.	1	2	3	4	5	6	7
53.	When I study for SD206, I pull together information from different sources, such as the tutorials, the course materials and discussions with others.	1	2	3	4	5	6	7
54.	Before I study new SD206 material thoroughly, I often skim it to see how it is organised.	1	2	3	4	5	6	7
55.	I ask myself questions to make sure I understand the material I have been studying on SD206.	1	2	3	4	5	6	7
56.	I try to change the way I study in order to fit SD206 course requirements and the way in which information is presented.	1	2	3	4	5	6	7
57.	I often find that I have been reading for SD206 but don't know what it was all about.	1	2	3	4	5	6	7
58.	I ask my tutor for SD206 to clarify concepts on the course I don't understand well.	1	2	3	4	5	6	7
59.	I memorise key words to remind me of important concepts in SD206.	1	2	3	4	5	6	7
60.	When SD206 course work is difficult, I give up or only study the easy parts.	1	2	3	4	5	6	7
61.	On SD206 I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying.	1	2	3	4	5	6	7

		not at all true of me						very true of me
62.	I try to relate ideas from SD206 to those from other courses whenever possible.	1	2	3	4	5	6	7
	When I study for SD206, I go over my notes and make an outline of important concepts.	1	2	3	4	5	6	7
63.								
64.	When reading for SD206, I try to relate the material to what I already know.	1	2	3	4	5	6	7
65.	I have a regular place set aside for studying SD206 material.	1	2	3	4	5	6	7
66.	I try to play around with ideas of my own related to what I am learning on SD206.	1	2	3	4	5	6	7
67.	When I study for SD206, I write brief summaries of the main ideas and concepts.	1	2	3	4	5	6	7
68.	When I can't understand SD206 course material, I ask another student on the course for help.	1	2	3	4	5	6	7
69.	I try to understand the material for SD206 by making connections between the readings and the concepts from tutorials.	1	2	3	4	5	6	7
70.	I make sure I keep up with the weekly readings and assignments for SD206.	1	2	3	4	5	6	7
71.	Whenever I read or hear an assertion or conclusion on SD206, I think about possible alternatives.	1	2	3	4	5	6	7
72.	I make lists of important terms in the SD206 and memorise the lists.	1	2	3	4	5	6	7
73.	I attend tutorials for SD206 regularly.	1	2	3	4	5	6	7
74.	Even when SD206 course materials are dull and uninteresting, I manage to keep working until I finish.	1	2	3	4	5	6	7
75.	I try to identify students studying SD206 whom I can ask for help if necessary.	1	2	3	4	5	6	7
76.	When studying for SD206 I try to determine which concepts I don't understand well.	1	2	3	4	5	6	7
77.	I often find that I don't spend very much time on the SD206 course material because of other activities.	1	2	3	4	5	6	7
78.	When I study for SD206, I set goals for myself in order to direct my activities in each study period.	1	2	3	4	5	6	7
79.	If I get confused taking notes in SD206 tutorials, I make sure I sort it out afterwards.	1	2	3	4	5	6	7
80.	I rarely find time to review my notes or readings before an exam.	1	2	3	4	5	6	7
81.	I try to apply ideas from course readings to other SD206 activities.	1	2	3	4	5	6	7

In the spaces provided below, could you indicate what you believed the numbers 2 - 6 on the rating scale represented when you filled in the questionnaire?

1 = Not at all true of me 2 = ...

3 = ... 4 = ...

5 = ... 6 = ...

7 = Very true of me

Use of the 'Human Brain' CD-ROM

General Computer Use

1. Had you used a computer prior to using the CD-ROM?

Yes ❑
No ❑

2. In what location(s) do you use a computer? *(please tick one)*

a) At home ❑
b) At my place of work ❑
c) Both home and work ❑
d) At some other location (please specify below) ❑

_____

3. How often do you use a computer? *(please tick one)*

a) Daily basis ❑
b) Less than daily ❑
c) Varies (between daily and occasional use) ❑
d) Not often at all ❑

4. For what purposes do you generally use a computer? (please indicate any that apply)

a) To run general purpose software (e.g. word processing, spread sheets) and printing ❑
b) To run specific commercial software ❑
c) Communications (i.e. e-mail) ❑
d) Internet/World Wide Web ❑
e) Games ❑

The 'Human Brain' CD-ROM

5. Approximately, how much time have you spent using the CD-ROM?

.....hours

6. Is this the first time you have used a multi-media CD-ROM on an academic course?

Yes ❑
No ❑

7. In what location(s) did you use the CD-ROM? *(please tick one)*

a) At home ❑
b) At my place of work ❑
c) At home and at work ❑
d) At some other location (please specify below) ❑

_____

8. How did you use the various sections of the CD-ROM? *(please tick any that apply for each of the sections)*

		Overview	Spinal Cord	Cerebral Cortex	Vision	Hearing	Speech	Hands on the Brain
a)	Initial tutorial	❑	❑	❑	❑	❑	❑	❑
b)	Revision	❑	❑	❑	❑	❑	❑	❑
c)	Reference	❑	❑	❑	❑	❑	❑	❑
d)	To learn about section	❑	❑	❑	❑	❑	❑	❑
e)	Yet to use	❑	❑	❑	❑	❑	❑	❑

9. Generally, how easy or difficult was the Human Brain CD-ROM to work through? *(please tick one)*

a) Very easy - presented no problems ❑
b) Reasonably easy – presented a few problems ❑
c) Rather difficult ❑
d) Very difficult ❑

10a. Was this the case for all sections of the CD-ROM?

Yes ❑
No ❑

10b. If no, please indicate the level of ease or difficulty for each of the sections. *(please tick one for each of the sections on the CD-ROM)*

		Overview	Spinal Cord	Cerebral Cortex	Vision	Hearing	Speech	Hands on the Brain
a)	Very easy - presented no problems	❑	❑	❑	❑	❑	❑	❑
b)	Reasonably easy - presented a few problems	❑	❑	❑	❑	❑	❑	❑
c)	Difficult	❑	❑	❑	❑	❑	❑	❑
d)	Very difficult	❑	❑	❑	❑	❑	❑	❑
e)	Yet to use	❑	❑	❑	❑	❑	❑	❑

11. How do you think the amount of time spent studying the CD-ROM compares with the time you would have spent studying the same material book/video form? *(please tick one)*

a) Much more time with CD-ROM ❑
b) About the same amount of time ❑
c) Less time with the CD-ROM ❑
d) Don't know ❑

12. How do you think using a CD-ROM to learn about the human nervous system compares with studying text and pictures in a printed book? *(please tick one)*

a) CD-ROM is much better ❑
b) Better for some topics only ❑
c) About the same overall ❑
d) CD-ROM is not as good ❑

13. How do you think using a CD-ROM to learn about the human nervous system compares with studying equivalent material on video? *(please tick one)*

a) CD-ROM is much better ❑
b) Better for some topics only ❑
c) About the same overall ❑
d) CD-ROM is not as good ❑

Style of the CD-ROM

14. Did you find the three-layered structure limiting, i.e. did it restrict your freedom to explore the material in whatever order you wanted to? *(please tick one)*

a) Very limiting ❑
b) Fairly limiting ❑
c) Not very limiting ❑
d) Not at all limiting ❑

15. Did you use the Index and/or the Map to explore the materials in the order you chose? *(please tick one)*

a) Yes, constantly ❑
b) Yes, mostly ❑
c) Yes, sometimes ❑
d) Not very often ❑
e) Not at all ❑

16. What did you feel about the amount of text, narration, pictures and video? *(please indicate one for each of the presentation categories)*

		Text	Narration	Graphics	Video
a)	There was too much	❑	❑	❑	❑
b)	It was about right	❑	❑	❑	❑
c)	There was too little	❑	❑	❑	❑

17. If there are any aspects of using the "Human Brain" CD-ROM that you feel have not been covered in this survey, or if you have any additional comments regarding the CD-ROM, please do use the space below.

This research is part of an ongoing project, would you be willing to be interviewed (either by phone or in person) in conjunction with this research. If so, it would be much appreciated if you would supply your contact details below. **It should be stressed that these details will be kept strictly confidential, acting solely as an avenue of contact.**

Name:

Address: .....

.....

.....

.....

.....

If you are willing to be interviewed could you please indicate a time below that would be convenient for you to be contacted by phone in the next few weeks to arrange an interview time.

10 a.m. to 12 p.m. ❑
2 p.m. to 4 p.m. ❑
6 p.m. to 8 p.m. ❑

Telephone: .....

APPENDIX D: Study II – Sample Transcript

Student 7 : interview carried out face to face

I = Interviewer

CH = Students initials

I	Ok lets start then...How did you find the course?
CH	Quite difficult to start with, a lot of long words that were new to me but once I got the language it was OK...I've done biology courses before hand and although it is still biology there was a lot of psychology a lot new words
I	How did you over come those difficulties
CH	Just repetition...going back over what I didn't understand...it didn't take long it was just that some of it was new
I	You say you studied other courses, were those with the OU as well?
CH	Yes
I	How many other courses have you studied with the OU?
CH	Science Foundation Course, fiscal resources, chemical environment and the form and functions of biology, which I am really pleased about it helped me for this course....
I	Can you tell me why you decided to use the CD-ROM?
CH	Because it was there and any help has got to be useful...I don't have a computer here but I found someone willing to let me use theirs ...I wanted to have a look at it...I found it quite useful
I	Have you had much experience of using computers?
CH	No none at all...this ws my first time...I haven't got a computer and I don't need one at all for my work...but my brother in law has one for his work so I got him to set it for me and used his
I	How did you find it as a novice using the CD-ROM?
CH	I found it quite fun actually...its tempting me to buy a computr because of it...it was just amazing what you can do with that. I found it very easy to use...I don't think I could have loaded it myself...I know I couldn't but with more computer background I probably could
I	Looking back how much time do you think you spent using the CD-ROM?
CH	Probably more time than I need to because of the novelty...a few hours each time but I'd keep going back in for half hour. 20 or 30 hours in total...I didn't sit in front of it for hours...probably an hour at a time roughly
I	Was some of that time spent learning the computer technology?

CH Not a great deal because the CD-ROM tells you exactly what you need to know...it tells what you to click so you don't need to now the technology

I Were you pleased that it worked in that way?

CH Oh yes...otherwise I would have given up and gone back to the books

I By the time you did get to use the CD-ROM did you use all the sections on the CD-ROM?

CH Yes I did

I When was it that you actually came to use the sections and I have some options for you here: was it when you actually used the other course material, in the midst of using that material or before you used the other course material?

CH I don't think it was ever before...sometimes in the midst but usually probaly after the section I found it good for revision...not necessarily revision for the exam but to see what I had learned

I How did it fit in with the other course material then?

CH That was the difficult bit because the computer wasn't here it was taking the opportunity when I could and I tried to go over to my brother-in-law's after I had finished a section...like vision I knew I needed to go and have a look ...but it had been here it would have been easier to keep going into it

I So because you had to go to the CD-ROM would you make notes on the things you wanted to look or would you look through the whole section?

CH I tended to take the books that were relevant with me so I knew which bits I wanted to look at at the time...I made notes whilst I was there from the CD-ROM...but anything on the CD-ROM is in the book anyway it just makes it clearer

I In what ways does it make it clearer?

CH Some of the pathways...it was difficult to see where they were from the books in your mind...again it was back down to the long words...looking at the CD-ROM with diagrams and the different colours helped it was easier to follow...it explained things simpler

I Did you have those diagrams on the videotape?

CH Yes we did but I think it was the fun of using the CD-ROM that got you into it a bit more...also with the video stopping and rewinding isn't quite as easy as clicking on a bit of the picture

I What was the fun aspect for you?

CH I think it was the novelty really...with the hands on the brain part I spent quite some time playing with it, turning it around when I didn't really need to...because you are there playing with you are getting it into your mind and the pictures there are [stored] longer...and the questions where you could click and see if you got it right and even if you are getting it wrong when you find the right answer it helps to put it into your mind

I Moving on to look at the features of the CD-ROM, the tool made use of a three-layered structure, how did this help you to work through the information in the sections

CH Some of the time I was going to bits I really didn't want to with that...it was a waste of time at the beginning...it gave you more detail

I Did you find it helpful for all sections?

CH Mostly, sometimes I got into parts I didn't want to be in or wasn't concerned with at the time

I You talk about taking you information you didn't want to know about...

CH There was one day I was looking for something in particular and I couldn't find it and I still couldn't find it in the end I kept on getting into the level 3 and took time trying to get back to level 1...it was probably because I was looking for something that wasn't even on the CD-ROM

I When you were coming to these avenues...how did they make you feel?

CH I felt that I had to backtrack all the time... then I would forget where I had been and ended going there again still looking for the same thing...I couldn't find a way of going across I had to keep going backwards...from the level 3 back through level 2 and then 1 and it just seemed to waste my time then...maybe its practice

I Did you feel frustrated about that at all?

CH I did a little bit...as I said this day I couldn't find what I wanted so back to the books

I So when you were looking through the 3-layered structure wrre you sometimes going through looking for specific aspects?

CH Sometimes yes

I and other times?

CH Just like a book...just browsing

I The CD-ROM also makes use of a series of other features? Can you tell a little about how each of these helped you study for the course? The images and the video animation?

CH They were both brilliant because you could see it and see it falling into place...I liked seeing how the brain built up and how it all fitted together

I How did relate to the images and diagrams you would get in the course texts or the video?

CH From the text courses sometimes it was iffiiuclt to use your imagination to see hwta it would look like from the other side or even how the picture was built up...some of the CD-ROM graphics built up step up by step so you could what was underneath each other as opposed to just one picture and work it out for yourself.

I How about the narration?

CH That got on my nerves sometimes after a while...but it was quite good to have it there because some of the pronunciation obviously became clearer

to hear somebody else say it rather than trying to read it out of the books...but the audio cassettes and the video helped with that as well.

I So why did it get on your nerves (jokingly)?

CH Sometimes it seemed to go on for too long...as if it were being read from a book...its difficult to say...if I was reading it I might have skipped a little bit I think that's the thing but if you are listening to someone you have to sit and listen until they are finished and you can't just skim the bit you want

I Is that the way you went through the traditional course material?

CH Not at the beginning because I tend to read the books quite thoroughly to start with but for the revision purpose and most of the CD-ROM was revising what I had done in the books...for revision you do tend to skim through and pick out the key words that you need and he was just going over and explaining over words...I was thinking come lets just get to it.

I How about the text and the text hotspots?

CH I liked the hotspots that was part of the fun of it again...it highlighted areas that obviously were important other wise they wouldn't have been there...I particularly liked the idea of different colours to say you had been there because at the start I kept on going to same ones all the time...but that was me not remembering I had been there...they were quite useful in highlighting areas I should pay more attention to

I Was it picking up information that you possibly skipped in the other texts?

CH Yes certainly...on one or two occasions there things that I though 'ooh I didn't realise that from the [course] texts or even from the video I somehow missed it

I The quick test facility, how did the questions help you in the study of the course?

CH Confidence building as much as anything...when I got them right I though crikey I have learnt something particularly with the vision I think you may have heard a lot of people say they struggled with the Vision section...well having seen that it helped me I felt I knew enough for the exam maybe not understood very well but I felt a bit more confident going into the exam and the questions there [in the quick-test] boosted the confidence...I was getting them right and it makes you feel a little bit better when you are getting things right

I If you did get question wrong did you find yourself going back to that information?

CH Go back certainly to it in the CD-ROM whilst I was there initially and occasionally not all the time I would go back to it in the book...again what was more important to me was whether I felt I new enough about it to carry on and learn properly or was this something I was going to skip anyway...towards the ned of the course you started to select hat you were going to use what you were going to study deeper to get the more marks in the exam...usually yes I would go back to it but sometimes it would be just too much

I What was the impact when you didn't answer the questions correctly?

CH I didn't worry too much about it...but it was useful to know where I needed to do a bit more work...going back to the text and doing a little bit or finding out I hadn't taken it in..not missed it but not realised its importance

I There were also the objectives for each section, how do you those on the CD-ROM?

CH I'm not very good with objectives even with the books...I tend to forget that they are there...I didn't use them as much as I should of done I just plunged into the section, didn't appreciate what I should of learned perhaps just too keen to get on with it...I'm nopt very good with objectives I should pay more attention to them. The only time I find them really useful is when I am preparing for a TMA and sometimes they give you clues to use objectives and it does help to form plans for that.

I Can you tell why the objectives did not play too large a role?

CH Because I though I went through everything on the CD-ROM and I should have always pay more attention to what it is trying to tell me but I tend to go in at look at it all anyway. On other courses as well...I tend to glance through them...and I always mean to go back and read them and make sure that I have them in my mind but they tend to get forgotten...it's just the way it is whether it is the CD-ROM or books.

I Do you think in the end you still got the information you needed?

CH I think so...because the questions at the end of the section whether the CD-ROM or the books helped reinforce what you had learnt and of course the coursework throughout the year if you don't know it you go back to it

I The CD-ROM also makes use of various tools. How did you come to use the glossary first off?

CH The glossary I did not tend to use...I looked through it but did not come to actually use it

I Did you use the Wordpad?

CH No...because of I am not very good with computers and not very sure how to use them

I Were you making your own notes?

CH Yes I was...pen and paper...because then I could take it away also I work with my books beside me and I used to make a lot of nmotes in my books

I From the CD-ROM what kind of notes were you taking and where were you taking them from?

CH Diagrams...they were useful to reinforce what I learned on the diagrams and also the pathways...it helped you understand those much more so I would take notes to understand what the pathways do...mostly it was the pathways I took notes about

I Did you make any printouts at all?

CH No

I Would you have liked to have had that facility?

CH Yes...saved me a lot of paperwork

I What kind of things would you have liked to have printed?

CH I would have certainly printed out a lot the diagrams and used those a lot more with my books but a lot of that was on the video but you have to keep looking for it and that was the problem

I How about the camera tool and the photoalbum

CH I had a look at it but didn't really use it...it didn't really help with my work...I didn't spend a lot of time with it... I saw what it did and then moved on.

I Looking back which section did you find most useful?

CH Most useful was probably the vision...really seemed to make thing much clearer than they were in the book or may be it was just the book that really helped me the CD-ROM put it all into place but certainly the vision section and the position of the parts of the brain that helped an awful lot...the structure of the brain I think it was called

I With those two section what kind of information what information were they most useful in providing?

CH The position of strucctures...different areas of the brain...the sight going right to the back of the brain why I didn't understand that from the books...but then it made more sense...I completely got it wrong in the book where the parts of the brain were but it [CD-ROM] sorted me out.

I What information do you find most useful in those sections, was it the pictorial or the text?

CH The images definitely...but the text was very useful you certainly couldn't have one without the other

I Did you experience any problems using the CD-ROM

CH No...initially though installation caused some problems and my brother-in-law had to get a friend in who knows more than he does and then they were able to load it

I At summer school they should have the CD-ROM, did you get use it there?

CH No, the time was taken up with other activities and I had access to it anyway

I Did you speak to other students CD-ROM either at summer school or tutorial?

CH Yes I know one friend who has a computer at home and she had trouble installing it at home, she spoke to someone at the University and even then she didn't get it loaded. Others had got it and it seems they didn't use it or they forgot about it or believed they got enough from the texts...I don't remember anyone being enthusiast it about it as much as I was...or perhaps I was talking to the wrong people

I So you did speak to other students about the CD-ROM?

CH Well when I managed to get it working we had a tutorial shortly after and I asked what people thought of it but I found that I was the only one using...but that was fairly on in the year I didn't mention it again

I When you were speaking to people about it what kind of things were they saying?

CH I don't think they could understand my entushiam...but for me it was the first time I had used a computer and I was quite keen to have a go...they didn't seem that interested

I If you could, what changes would you make to the CD-ROM?

CH More of it...I was just getting into and the bits I wanted more detail on just wasn't there I had to go back to the books, I certainly would like more things on the CD-ROM

I What kind of things?

CH More pictures...perhaps more text the text annoyed me because maybe there was too much of it at one point if I was going to it fresh without using the text books as much as I did that text would have been more useful

I Would you like more of the material from the video placed on the CD-ROM?

CH I'd like to see the more of the video on the CD-ROM more because you can interact with more on the CD-ROM whereas you can't with the video where you can just watch it; rewind; and watch it again...the reason I liked the CD-ROM was that you could stop it and play with it much more...join in...the questions are there it tells you got it wrong straight away

I Final question, what was the thing you got the most out of from using the CD-ROM?

CH Because it was fresh...from the books you can tend to bogged down a little bit so you got another point of view coming out...something fresh...when you sit infronnt of it you have moving pictures I know you have that on the video but there it just runs and you can walk away and think what have I missed but with the CD-ROM because it is sort of up to you to turn the page you are joining in with it keeps you awake and keeps you alert...it is like you are turning the pages...you have the moving pictures and the narration...it is easier than reading a full text book

I Would you use this sort of multimedia in other courses you studied?

CH Yes I would...it used to frighten me the idea of having to use a computer with my work...I've not actually avoided courses with a computer but have though twice about but I now I'm prepared about thinking about going out to get a computer...not just for the courses but for everything

I Would you like to see this kind of tool in more OU courses?

CH Yes I would...but there is always the worrying aspect that you are going to put off pther students joining the courses then it can become pretty expensive that's got to be a worry...would it put other students off if they haven't got a computer?

I Thank you

APPENDIX E: Study III – SPOTLITE Questionnaire

SD206: The 'Human Brain' CD-ROM Questionnaire

Part A. Motivation for using the Human Brain CD-ROM

Each of the items below refers to motivational aspects about using the CD-ROM. For each item circle the response which you believe best reflects your experience or belief. There are no right or wrong answers, just answer as accurately as possible and please *answer all items*. Use the scale of 1-4 to respond to each item. *(Please circle one only in each row.)*

1 = not at all true of me 2 = not very true of me 3 = fairly true of me 4 = very true of me

1.	I used the CD-ROM because I was curious about how the information would be presented	1	2	3	4	*(14)*
2.	I think computers make information more accessible than books	1	2	3	4	*(15)*
3.	I expected the CD-ROM to make it easier to understand the information in the books	1	2	3	4	
4.	I expected the CD-ROM to give me an idea of what were the important concepts I had to learn about from the other course materials	1	2	3	4	
5.	I used the CD-ROM because it allowed me to examine biological structures and processes in a way that I could not with the audiocassettes, video and the model of the brain	1	2	3	4	
6.	I expected the CD-ROM to provide additional information to the books	1	2	3	4	
7.	I believe one reason why computers can be considered useful is that they can present information differently from books	1	2	3	4	*(20)*
8.	I generally like to make use of all course material	1	2	3	4	
9.	I expected the information on the CD-ROM to make it easier to understand the information from the audio cassettes, video and model of the brain	1	2	3	4	
10.	I decided to start using the CD-ROM because it was available	1	2	3	4	
11.	I think computers offer advantages when it comes to learning and studying	1	2	3	4	
12.	I expected the CD-ROM to provide additional information to the audio cassettes/video.	1	2	3	4	*(25)*
13.	I used the CD-ROM because it made topics easier to understand compared to the other course material	1	2	3	4	
14.	I decided to start using the CD-ROM because I thought it would make the topics I was studying clearer	1	2	3	4	
15.	I used the CD-ROM because it allowed me to examine biological structures and processes in a way that I could not with the books	1	2	3	4	
16.	I think computers are beneficial in everyday life	1	2	3	4	
17.	I used the CD-ROM because it was part of the course materials	1	2	3	4	*(30)*

Part B. Studying the information on the Human Brain CD-ROM

Each of the items below refers to the study of the information on the CD-ROM. Again, for each item circle the response that you believe best reflects your experience of using the CD-ROM. There are no right or wrong answers, just answer as accurately as possible and please *answer all items*. Use the scale of 1-4 to respond to each item. *(Please circle one only in each row.)*

1 = not at all true of me 2 = not very true of me 3 = fairly true of me 4 = very true of me

18.	I found the information on the CD-ROM increased my understanding of the information in the books	1	2	3	4	*(31)*
19.	I looked at the objectives before going through each section of the CD-ROM	1	2	3	4	
20.	I took hand written notes from the CD-ROM	1	2	3	4	
21.	I copied diagrams from the CD-ROM into my own notes	1	2	3	4	
22.	I went through a topic on the CD-ROM before looking at it in the other course material	1	2	3	4	*(35)*
23.	I used the Quicktest facility to test how much information I had taken in from the CD-ROM	1	2	3	4	
24.	The CD-ROM increased my understanding of the information from the audiocassettes, video and the model of the brain	1	2	3	4	
25.	I found the Quicktest facility on the CD-ROM useful	1	2	3	4	
26.	I made notes using the Notebook word processing facility on the CD-ROM	1	2	3	4	
27.	I referred back to the objectives as I worked through each section of the CD-ROM	1	2	3	4	*(40)*
28.	I used the CD-ROM alongside the books to help me to understand the topics I was studying	1	2	3	4	
29.	I used the CD-ROM to make additional notes to the ones I made from the other course material	1	2	3	4	
30.	I used the CD-ROM to give me an idea of what were the important concepts in the other course material	1	2	3	4	
31.	I looked at the questions in the Quicktest facility after I completed each topic on the CD-ROM	1	2	3	4	
32.	I looked at the objectives after completing each section on the CD-ROM	1	2	3	4	*(45)*
33.	I printed off diagrams and images from the CD-ROM	1	2	3	4	
34.	I used the CD-ROM to look up specific items of information	1	2	3	4	
35.	I found the objectives on the CD-ROM useful	1	2	3	4	
36.	I would look at relevant sections of the CD-ROM after I had studied the course material	1	2	3	4	
37.	I used the questions in the Quicktest facility for revising	1	2	3	4	*(50)*
38.	I was concerned that I understood the information on the CD-ROM	1	2	3	4	
39.	I went through all the Quicktest questions for the sections of the CD-ROM I studied	1	2	3	4	*(52)*

Part C. Using the Human Brain CD-ROM

Each of the items below refers how you came to use the CD-ROM. Again, for each item circle the response that you believe best reflects your experience of using the CD-ROM. There are no right or wrong answers, just answer as accurately as possible and please *answer all items*. Use the scale of 1-4 to respond to each item *(Please circle one only in each row.)*

1 = not at all true of me 2 = not very true of me 3 = fairly true of me 4 = very true of me

					CARD 2	*(1)*
40.	I did not have enough time to look through all the sections of the CD-ROM	1	2	3	4	
41.	I read all the text on the CD-ROM for the sections I studied	1	2	3	4	
42.	I found the Map feature useful in helping me navigate around the *CD-ROM*	1	2	3	4	
43.	I found the tools on the CD-ROM (i.e. Camera, Album, Ruler) difficult to use	1	2	3	4	*(5)*
44.	I liked the narration on the CD-ROM	1	2	3	4	
45.	I often found myself getting to a screen on the CD-ROM and then wondering how I got there	1	2	3	4	
46.	I often found that I became lost in the layers of information on the CD-ROM	1	2	3	4	
47.	I preferred the graphics on the CD-ROM to the text or narration	1	2	3	4	
48.	I thought it important to use the tools (i.e. Camera, Album, Ruler) on the CD-ROM	1	2	3	4	*(10)*
49.	I went through the tutorial before going through the other sections of the CD-ROM	1	2	3	4	
50.	Before going through the various sections I looked through the CD-ROM to see what would be useful	1	2	3	4	
51.	I had difficulty making the tools on the CD-ROM (i.e. Camera, Album, Ruler) work properly	1	2	3	4	
52.	*I did not place a limit on the time I spent using the CD-ROM*	1	2	3	4	
53.	I found it easy navigating around the CD-ROM	1	2	3	4	*(15)*
54.	I had a go with each of the tools on the CD-ROM, before deciding whether or not to use them	1	2	3	4	
55.	I used the reference facility on the CD-ROM	1	2	3	4	
56.	I liked the graphics on the CD-ROM	1	2	3	4	
57.	I thought there was too much text on the CD-ROM	1	2	3	4	
58.	I found it easy to look for and find the information I wanted on the CD-ROM	1	2	3	4	*(20)*
59.	Before studying a particular section on the CD-ROM I had a quick look through it to see what it covered	1	2	3	4	
60.	I went through all the layers of information for each of the sections I studied on the CD-ROM	1	2	3	4	
61.	I could usually find my way back through the information on the CD-ROM to places of interest or importance	1	2	3	4	
62.	I did not use the tools on the CD-ROM (i.e. Camera, Album, Ruler) because I thought it would take too long to learn how to use them	1	2	3	4	*(24)*

63.	I found the tools on the CD-ROM (i.e. Camera, Album, Glossary, Ruler) useful	1	2	3	4	*(25)*
64.	I liked the text and the text hotspots on the CD-ROM	1	2	3	4	
65.	I turned the volume down before the narration ended	1	2	3	4	
66.	I used the Trail facility to see what material I had covered in the section I was studying	1	2	3	4	
67.	I would have liked to have spent more time looking at the CD-ROM	1	2	3	4	
68.	I used the Map facility to 'jump' to a particular point on the CD-ROM that I wanted to go to	1	2	3	4	*(30)*
69.	I had a look at what the various tools (i.e. Camera, Album, Ruler) on the CD-ROM did but decided not to use them	1	2	3	4	
70.	In the sections of the CD-ROM that it occurred, I found it useful having the information organised into 3 layers	1	2	3	4	
71.	I used the glossary facility on the CD-ROM	1	2	3	4	
72.	I used the Trail facility to return to parts of the sections I previously covered	1	2	3	4	*(34)*

Part D. General information

73. Had you used a computer prior to using the CD-ROM? *(35)*

Yes	1
No	2

74. In what location(s) do you use a computer? *(please circle one only)* *(36)*

a)	At home	1
b)	At my place of work	2
c)	Both home and work	3
d)	At some other location (*please specify below*)	4

_____

75. How often do you use a computer? *(please circle one only)* *(37)*

a)	Daily basis	1
b)	Less than daily	2
c)	Varies (between daily and occasional use)	3
d)	Not often at all	4

76. For what purposes do you generally use a computer? (*please circle all that apply*)

a)	To run general purpose software (e.g. word processing, spread sheets) and printing	1	*(38)*
b)	To run specific commercial software	1	
c)	Communications (i.e. e-mail)	1	
d)	Internet/World Wide Web	1	
e)	Games	1	*(42)*

77. Approximately, how much time have you spent using the CD-ROM? _____hours *(43-44)*
(Please enter two digits ie 01= 1 hour or 10 = 10 hours)

78. Is this the first time you have used a multi-media CD-ROM on an academic course?

Yes	1
No	2

79. In what location(s) did you use the CD-ROM? *(please circle one only)* *(46)*

a)	At home	1
b)	At my place of work	2
c)	At home and at work	3
d)	At some other location (please specify below)	4

_____

80. What sections on the CD-ROM have you studied? (*please circle all that apply*)

a)	Overview	1	*(47)*
b)	Hands on Brain *(rotatable model of the brain which allows various substructures to be highlighted)*	1	
c)	Cerebral Cortex	1	
d)	Spinal Cord	1	
e)	Vision	1	
f)	Hearing	1	
g)	Speech	1	*(53)*

81. Were you studying SD206 as part of the requirements for recognition of your degree by the British Psychological Society ?

Yes	1	*(54)*
No	2	

This research is part of an ongoing project, would you be willing to be interviewed (either by phone or in person) in conjunction with this research. If so, it would be much appreciated if you would supply your contact details below. **It should be stressed that these details will be kept strictly confidential, acting solely as an avenue of contact.**

Name:

Address:

If you are willing to be interviewed could you please indicate a time below that would be convenient for you to be contacted by phone in the next few weeks to arrange an interview time.

10 a.m. to 12 p.m. ❑
2 p.m. to 4 p.m. ❑
6 p.m. to 8 p.m. ❑

Telephone: .....

COMMENTS SECTION

Please use the space below if there are any aspects of using the "Human Brain" CD-ROM that you feel have not been covered in this survey, or if you have any additional comments to make regarding the CD-ROM.

APPENDIX F: Study III - Findings of Item Analysis

Table F.1: Item analysis of Motivation items

	Proportion of Keyed *Response %*	Item Correlation *(dichotomus)*	Item Correlation *(full scale)*
Q1	81.4	.18	.25
Q2	55.7	.49	.52
Q3	82.9	.45	.58
Q4	77.1	.40	.45
Q5	79.3	.49	.55
Q6	61.4	.48	.48
Q7	96.4	.53	.62
Q8	87.1	.32	.30
Q9	88.6	.41	.58
Q10	85.6	.37	.46
Q11	84.3	.46	.70
Q12	72.1	.54	.55
Q13	68.6	.59	.70
Q14	94.3	.49	.68
Q15	82.9	.60	.61
Q16	91.4	.32	.43
Q17	80	.35	.40

Table F.2: Item analysis of Cognitive items

	Proportion of Keyed Response	Item Correlation (dichotomus)	Item Correlation (full scale)
Q18	76.4	.56	.53
Q19	33.6	.37	.43
Q20	17.1	.36	.40
Q21	10.1	.41	.49
Q22	26.4	.28	.31
Q23	70.7	.58	.60
Q24	73.7	.60	.69
Q25	71.4	.62	.68
Q26	8.6	.45	.54
Q27	25.7	.49	.64
Q28	60	.52	.59
Q29	20	.46	.53
Q30	67.1	.47	.53
Q31	54.3	.55	.58
Q32	32.1	.58	.60
Q33	15.7	.41	.50
Q34	62.1	.37	.44
Q35	51.4	.60	.62
Q36	54.3	.57	.61
Q37	64.3	.52	.62
Q38	64.3	.51	.53
Q39	52.1	.59	.66

Table F.3: Item analysis of Tool Management items

	Proportion of Keyed Response	Item Correlation (dichotomus)	Item Correlation (full scale)
Q40	44.3	.10	.04
Q41	64.3	.19	.24
Q42	75.7	.45	.54
Q43	62.1	.38	.37
Q44	81.4	.24	.29
Q45	78.6	.38	.39
Q46	77.9	.50	.51
Q47	50.7	.17	.05
Q48	23.6	.40	.33
Q49	49.3	.32	.30
Q50	50	.45	.53
Q51	67.1	.38	.34
Q52	22	-.04	-.13
Q53	82	.45	.40
Q54	50	-.13	-.27
Q55	47.9	.46	.52
Q56	90	.35	.46
Q57	17.1	.02	-.10
Q58	72.1	.61	.63
Q59	56.4	.43	.40
Q60	33.6	-.10	-.21
Q61	83.6	.42	.56
Q62	72.9	.31	.31
Q63	31.4	.53	.50
Q64	83.6	.41	.47
Q65	15.7	-.05	-.06
Q66	29.3	.48	.49
Q67	82.9	.17	.21
Q68	52.9	.59	.61
Q69	70.7	.23	.19
Q70	75.7	.36	.37
Q71	59.3	.49	.48
Q72	38.6	.50	.59

APPENDIX G: Study III - Scree Plots

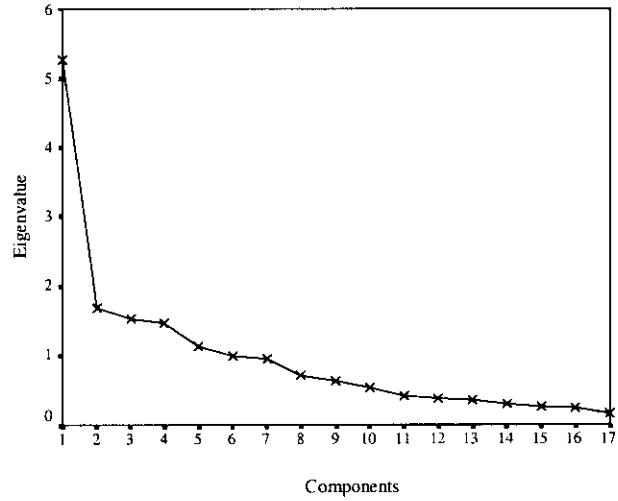

Figure G.1: Scree Plot of potential factors from the remaining Motivational Items

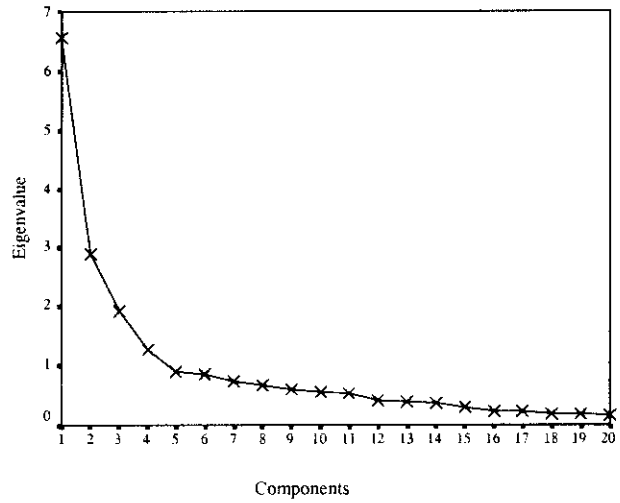

Figure G.2: Scree Plot of potential factors from the remaining Cognitive Items

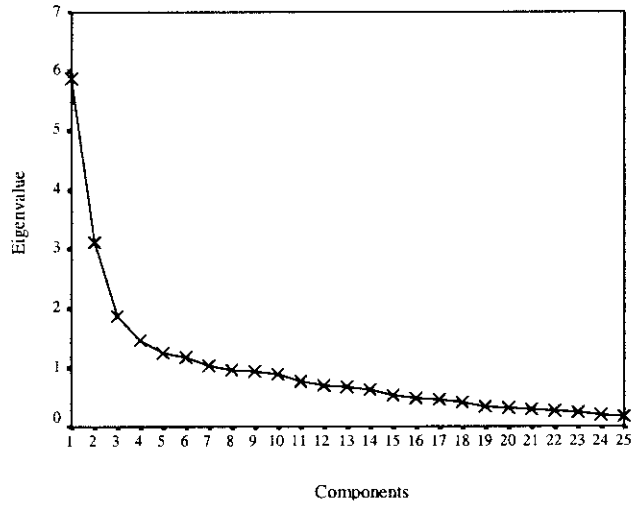

Figure G.3: Scree Plot potential factors from the remaining Tool Management

APPENDIX H: Factor Loadings

In the tables all the factor loadings are given for all the items and all the factors, in bold are the significant factor loadings.

Table H.1: Rotation of factors from Motivation Items

	I	II	III	IV
Item	**Format**	**Resource**	**IT Potential**	**Expectancy**
Q15	**0.77**	0.17	-0.17	-0.24
Q5	**0.71**	0.01	-0.01	-0.28
Q14	**0.70**	0.45	-0.35	-0.17
Q4	**0.65**	-0.15	-0.19	-0.03
Q13	**0.64**	0.21	**-0.58**	-0.27
Q9	**0.61**	0.30	-0.12	-0.42
Q3	**0.60**	0.18	-0.43	-0.15
Q17	0.01	**0.78**	-0.18	-0.04
Q8	0.11	**0.65**	0.22	-0.32
Q10	0.20	**0.57**	-0.36	0.03
Q11	0.44	0.29	**-0.78**	-0.37
Q2	0.41	-0.01	**-0.73**	-0.12
Q16	0.00	0.31	**-0.71**	-0.23
Q6	0.22	0.00	-0.13	**-0.85**
Q12	0.27	0.12	-0.27	**-0.83**
Q7	**0.54**	0.40	-0.21	**-0.57**

(Four factors explain 59% of the total variance)

Table H.2: Rotation of factors from Cognitive Items

	I	II	III	IV
Item	**Knowledge**	**Self-test**	**Notetaking**	**Objectives**
Q18	**0.78**	-0.37	0.01	-0.19
Q24	**0.73**	-0.49	0.24	-0.34
Q34	**0.72**	-0.12	0.16	-0.12
Q28	**0.67**	-0.14	0.32	-0.46
Q36	**0.67**	-0.23	0.29	-0.45
Q30	**0.63**	-0.23	0.00	-0.50
Q39	0.24	**-0.90**	0.07	-0.31
Q25	0.35	**-0.88**	0.16	-0.19
Q23	0.22	**-0.87**	0.12	-0.15
Q31	0.21	**-0.84**	0.00	-0.23
Q37	0.25	**-0.81**	0.14	-0.24
Q21	0.19	-0.14	**0.84**	-0.27
Q20	0.00	-0.13	**0.83**	-0.27
Q29	0.29	-0.11	**0.80**	-0.39
Q33	0.39	-0.14	**0.59**	-0.29
Q35	0.40	-0.24	0.31	**-0.78**
Q27	0.35	-0.22	0.49	**-0.75**
Q19	0.13	-0.05	0.32	**-0.74**
Q32	0.20	-0.44	0.25	**-0.64**
Q36	0.43	-0.39	-0.05	**-0.57**

Note: Item excluded – Q22 and Q26 (four factors explain 63% of the variance)

Table H.3: Rotation of factors from Tool Management Items

Item	Feature satisfaction I	Tool Use II	Failure III	Window Shopping IV
Q70	**0.69**	-0.12	0.02	0.15
Q56	**0.64**	0.09	0.22	0.23
Q64	**0.64**	0.00	0.36	0.14
Q42	**0.61**	-0.20	0.11	0.33
Q61	**0.56**	0.21	0.39	0.49
Q41	**0.55**	-0.06	0.12	-0.03
Q44	0.39	0.32	0.16	0.18
Q49	0.37	-0.10	0.00	0.22
Q63	0.16	**-0.76**	0.14	0.32
Q48	0.03	**-0.71**	0.04	0.12
Q54	-0.17	**0.71**	0.06	-0.33
Q62	0.09	**-0.55**	0.32	0.06
Q45	0.38	0.07	**0.80**	0.02
Q46	0.44	0.07	**0.75**	0.23
Q43	0.05	-0.19	**0.67**	0.11
Q51	-0.04	-0.14	**0.61**	0.17
Q53	0.44	0.22	0.48	0.38
Q59	-0.04	-0.10	0.08	**0.74**
Q50	0.18	-0.18	0.19	**0.68**
Q58	0.60	0.15	0.34	**0.60**
Q71	0.32	-0.39	0.05	**0.57**
Q68	0.34	-0.48	0.24	**0.57**
Q66	0.30	-0.40	-0.15	**0.56**
Q72	0.43	-0.47	0.07	**0.52**
Q55	0.40	-0.44	-0.10	**0.51**

Note: Items excluded because of Item Analysis – Q40, Q47, Q52, Q57, Q60, Q65, Q67, Q69; items failing to load on to factors – Q44, Q49 and Q53. (Four factors explain 49% of the variance)

APPENDIX I: Study IV – Sample Transcript

Interview carried out face to face

INTERVIEWER: How did you find the course?

S19: Difficult, more difficult than the other. I think that's more to the fact that there was a lot of psychology involved as well as biology and I think, because I discussed this at summer school with a lot of other students, that there was quite a divide between the psychology and biology people. I found the biologists wanted it more: this is it, this is how we can prove it; whereas the psychologists were a bit more 'well we're not quite sure' it's a bit more wishy washy, there was no set 'this is what happens and this is not what happens, a bit fuzzy. The psychology side of it wasn't black and white. The hardest bit about it there was no clear end to what you were doing, especially the essays, it was 'this is my opinion but it's probably not true' whereas most of the essays I have written before were based on facts so they were a little bit more difficult in that way.

INTERVIEWER: You talked about it being difficult to the other two you had studied. Are those OU courses?

S19: Yeah because last year I did Biology: Form and Function and the year before that I did the Science foundation course.

INTERVIEWER: Are you going for a named degree?

S19: Yeah, I've knocked it on the head for this year because Ive just started a new job so I wanted to make sure I settled into that but I'll pick it up the year after and I'm hopefully going to get the Biological sciences with a bent towards biology rather than chemistry or physics.

INTERVIEWER: So, can you tell me why you decided to study this particular course, SD206?

S19: Because I wanted to get as many biology points or courses as possible and this one was a Level 2 and there was only two Level 2 courses that were offered: Form and Function, and Brain and Behaviour. So that's why I done this one. Plus, I mean I have got an interest in it but I thought it would be a lot more physiology of the nervous system and the brain. Whereas, a lot if was why things happen and why we do it rather than how it's done but it was enjoyable, difficult but enjoyable.

INTERVIEWER: Turning to working with computers, how would you describe your general level of computing expertise?

S19: Not bad, not brilliant, a lot the programs and bits and pieces I'm not very good at but I can get by on most things like the Internet and things like that I'm still relatively a beginner because I don't use it that often but the actual packages, software like Works and Word and Excel I'm not to bad on.

INTERVIEWER: You talk about using the Internet and other things, what kinds of things were you doing on the computer generally?

S19: Well I only used when I was doing my course and I used it mainly for writing essays and for the results of experiments, I used the spreadsheet and those are the two main things I have used with it but because this my partner's work computer we have to be carefully about we use it.

INTERVIEWER: You talked about what you used it for but how long have you actually been using computers?

S19: Since about 1992, because I was in the army before this new job and one of the blokes I worked for in 1992 he was very into computers. He'd done an OU degree in computer science so I learnt a lot from him and he had his computer's plus the army stock so we had to use them from there.

INTERVIEWER: Did you find yourself doing the same kinds of things you talked, wordprocessing, databases...?

S19: Yeah, it was lot more database stuff because, I worked for the medical centre, we tried to get all the patients names on the computer and basically it was messing about to see what happened and learning from there. I have done a little bit of the old programming, C++ I think it was, I had a bit of a go at that because another friend of mine was writing his own game on computer so I used to have a fiddle around with him but it was a bit too beyond me so I moved away from that rather rapidly.

INTERVIEWER: Turning to the CD-ROM. The CD-ROM was sent to you about 6 weeks into the course but you should have been told that there was this CD-ROM and it was an optional piece of course material. So you knew about it at the beginning, so back then what were your initial thoughts about the CD-ROM, the fact that it was there?

S19: It was good, because I found with a lot of the courses it's mainly sitting down reading a text and making your own notes and there is nothing else, you have tutorials once a month or something, but apart from that you are on your own and it's just reading mainly. Having a CD-ROM along with the course, means it's a bit more interactive and you can picture with this [referring to the CD-ROM] better in your own mind where things are and that sort of things so yeah it's a good idea that they actually got it.

INTERVIEWER: What kinds of things were you expecting to be on there or just generally of the CD-ROM?

S19: Well, I was hoping, well obviously it had the brain and the nervous system and how things worked in the nervous system and where things were in the brain because I knew we'd be getting a model of the brain but you would have to look at that and the text, whereas on the CD-ROM it would be the whole thing together.

INTERVIEWER: Were you influenced at all by the fact that it meant using a computer?

S19: Yeah, partly because I do like fiddling with computers so having something on the course to use was interesting.

INTERVIEWER: Did you find you used all the course materials when you studies the course?

S19: I didn't use the brain [the plastic model]. I tended to use this [the CD-ROM] more than the model but yeah everything else I used...in fact no I didn't use the video's because I kept forgetting to video them but I used some of the audio tapes, I used the CD-ROM and I used all the texts.

INTERVIEWER: With the videotapes. Did you use the ones that were sent to you?

S19: Yeah, I used them ones but the ones that were on the TV I didn't use because I kept forgetting to record them.

INTERVIEWER: What was the reason behind not using the plastic model but using the CD-ROM?

S19: It was more because with the CD-ROM you can move over an area and it will tell you what it is rather than having it your hand but not having it labelled. I mean it [the plastic mode] to look at and get an idea of what the brain looked like but looking at it you had to look at the text or a diagram to see what bit...where as with this [the CD-ROM] it was a bit more concise...it showed you more exact where things were on there [the CD-ROM] than using the actual model of the brain because you had to look at the diagram in the book and then go from there to where it was, I preferred using this [the CD-ROM] plus the fact it was on the computer and was easier.

INTERVIEWER: Looking back, how much time do you think you spent with the CD-ROM?

S19: I spent a lot of time during Book 2, where it went through the brain and the structures. I used it a helluva lot of then. I used it virtually every time I studied then, the brain part [of the course] I used it [the CD-ROM] all the time so I knew exactly where things were.

INTERVIEWER: Can you give me an estimate in hours?

S19: I studied for about 1 hour, 2 hours everyday. So about 20 – 30 hours, something like that. It's hard to say, about 20-30 hours.

INTERVIEWER: Sounds like though that you have the CD-ROM on, but you're not using it all the time.

S19: Not all the time because you are writing notes and the rest of it, but when it came to looking for parts of the brain and working out what they're for I was that [the CD-ROM] as well.

INTERVIEWER: Was that spread a series of weeks...?

S19: Yeah weeks I can honestly remember how long it took to do the thing, quite a while because it is quite thick book [Book 2] and it was heavy going.

INTERVIEWER: Looking at the CD-ROM. We've juts installed it and it asking us do we want to load the records of our previous sessions. What would you normally click?

S19: When I was using it I would click no.

INTERVIEWER: Did you save the sessions?

S19: I did a couple of times but obviously because it's not our computer we couldn't save too much on it because if the company asks for it back of all a sudden and they found...I didn't want to take that chance.

INTERVIEWER: Would you have liked to have saved the records?

S19: I think I saved it more because I wanted to use everything. If the CD-ROM had been, not a lot more in-depth, but there's a lot more content on it and you're working it through then yeah I would want to save as I was went through...but as I say it's a work computer and I didn't want to take the chance.

INTERVIEWER: Can you click on the CONTENTS button for me.

S19: [PERFORMS ACTION]

INTERVIEWER: Could you click on the How to use the system for me please

S19: [PERFORMS ACTION]

INTERVIEWER: Did you use this section at all?

S19: No, typical bloke, jump straight in, push the buttons and see what happens.

INTERVIEWER: Did you open it at all just to see what was on there?

S19: I did when I first turned it on and juts flicked through because I didn't want to muck it up or anything so yeah I did have a quick read through but didn't actually take in what was going on I just jumped straight in really.

INTERVIEWER: You didn't go through that system and it tells you how to use the CD-ROM and what's on there, did you feel working through the CD-ROM that you should have done that section?

S19: Some parts, when I was going through some of the bits and pieces I wasn't sure what I was supposed to do and I just muddled my way through and sometimes then I though 'if I actually looked at that section it might have been quicker' but for quickness really rather than wanting to know how.

INTERVIEWER: If we could go back to the Contents page could you tell me what sections you came to use of had a look at?

S19: [PERFORMS ACTION] Everything, I looked at everything. The ones I looked at more than the others were: Hands on the brain and the Cerebral Cortex one.

INTERVIEWER: The Hands on the brain is quite different from the other sections in that it isn't information for you look round it's more that you can move things around. So what was it about that sections you used it often?

S19: You could fiddle about with it and look at it as whole and the whole way round rather than just having a picture, a 2D picture and just looking at it and reading the text. With this you could actually fiddle with rather than just reading again, to get away from the reading thing.

INTERVIEWER: What section did you find the most useful?

S19: The Hands on the Brain, in fact both of them were really: the Hands on the brain and the Cerebral Cortex again because I dint know that much about the brain because Form and Function, it covered it but it didn't really go too in-depth into it.

Whereas, the Spinal Cord, the Vision and all that [referring to the other sections on the CD-ROM], I knew a fair bit about.

INTERVIEWER: What did you think about those other sections?

S19: They were alright, helpful but didn't use them as much as the other ones.

INTERVIEWER: Can you open up the Cerebral Cortex for me please.

S19: [PERFORMS ACTION]

INTERVIEWER: Could you just flick through some or all of the screens of that section and tell me the kinds of things you found useful.

S19: This one [SCREEN 1] this came up [TEXT BOX] and plus the fact it was the different cokours [referring to image of Cerebral Cortex] if I remember correctly the text [course texts] had the areas but no colour involved. So that's why it was bit more 'it starts here and finishes here' type thing [referring to structural boundaries indicated by colours on the image].

INTERVIEWER: You mentioned the thing that came up, the text box.

S19: Yeah, you just click and it came up and it gives you a brief outline of what happens in that area or what it does. [SCREEN 3 FUNCTIONAL DIVISION, GOES DOWN FURTHER LEVEL TO SENSORY HOMUNCULUS AND COMPARATIVE ANATOMY OF VARIOUS SPECIES] They did mention this is the text, just looking at the different sizes and this again because it's in colour its gives you a better indication of what the differences are rather than just giving you an area.

INTERVIEWER: You said before that you spent about 20-30 hours with the CD-ROM. How much of that time was spent looking at the Cerebral Cortex and the Hands on the Brain?

S19: Most of it.

INTERVIEWER: So the other sections were they still spread over a series sessions or day going through Vision and then another...?

S19: Yeah it was like using it one bit at time. I think with the Vision and the Sound and that side of it [referring to the other sections on the CD-ROM], it was more doing the text thing [looking at the course materials] and then going to this just to get a bit more of an overview of what it was all about. I just found it easier to read this than read the books.

INTERVIEWER: You said before that when you using the CD-ROM you were using the book at the same time. So, how as it happening. Was it case of reading something in the text and then coming to the CD-ROM or the other way around?

S19: It was more reading the book, reading the text then using the CD-ROM. Very rarely the other way round. I think when I was reading the text [course material] I looked at the diagrams and if I wasn't 100% sure I came on to this [the CD-ROM] and I used this as well and I think I got a better...it's hard to explain...it was just a darn sight easier looking at this [the CD-ROM] than it was reading the text but then again it might just be the way I do it – visual more than just reading it.

INTERVIEWER: Juts to clarify, how did it come about this studying with the two together?

S19: It came about through reading book and thinking 'this is not going in really well' and so then using that [the CD-ROM], as soon as I got it I used it [the CD-ROM] and I hadn't actually got to Book 2 by then because I was way behind before I even started so I then fiddled with this [the CD-ROM] and then started doing Book 2 and then went back to this [the CD-ROM].

INTERVIEWER: Was it a case of it [the CD-ROM] came through the door and you had a look at it that night?

S19: Yeah.

INTERVIEWER: What were you looking for?

S19: I think it was curiosity what's it going to be, what's going to be on it, is going to be sort of like another format of text or something a bit more interesting. So just chucked it on and had a look.

INTERVIEWER: Did you use the CD-ROM for revision at all?

S19: No, I didn't because to be perfectly honest I didn't do that much revision because lots of things were going on at the time...I mean I read books but I didn't have my computer with me when I was at work a lot it was easier to read the books then. At work they got computer but only one or two that had CD-ROM on them and they happened to be in my managers office so he wouldn't let me go in and push him out of the way and say 'here let me use your computer'.

INTERVIEWER: Comparing the CD-ROM to the information in the other course material – what would you say about that?

S19: It's very good [the CD-ROM], it's really really helpful, immensely helpful in that it's pictures and colours and it's a lot easier than just sitting there so it's good. I prefer it over the text in the book.

INTERVIEWER: Did you have any trouble moving around the CD-ROM, navigating?

S19: No, not that I can remember.

INTERVIEWER: Did you ever want to find something specific and get there straight away?

S19: I don't think...I didn't go through it looking for something specific it was more like going to a general area where it would be and then flick through until I found it.

INTERVIEWER: Did you go through all the screens on the sections?

S19: Yes, I went through the whole lot.

INTERVIEWER: Did you try and go through all the things that you click on?

S19: Yeah, not so much on the Spinal Cord, Vision, Sound and all that but definitely on the Cortex one.

INTERVIEWER: The buttons on the side, did you make use of all of those?

S19: I did the Objectives and the Quicktest.

INTERVIEWER: Okay, I'm going to ask you about those two later on. The Index.

S19: I didn't use that much.

INTERVIEWER: Could you click on the Index button for me?

S19: [PERFORMS ACTION].

INTERVIEWER: Could you click on Map for me. What do you think that actually does.

S19: [PERFORMS ACTION, MAP ON SCREEN]. I presume that this goes to the different pages...it's just another way of getting through...getting to the different areas and each section is broken down into even more.

INTERVIEWER: What's it broken down based on?

S19: Screens? I take it these plus and minus [EXPANSION ICONS] on a normal computer the tree...

INTERVIEWER: The Explorer Window. Now that you have seen it, what do you think about it?

S19: Yeah, now that I have seen it very good. I think I would have used it more if I had kind of bothered to look at them a bit more.

INTERVIEWER: Was that something you could have done with whilst you were using the CD-ROM?

S19: Yeah, I think so.

INTERVIEWER: No what I would like to talk to you about are the features of the CD-ROM. What I mean by a feature is an element common to all sections of the CD-ROM. We're looking at the Cerebral Cortex there and you are looking at the 3rd screen of five and what you have got there is an image of the brain. So images appeared on all the sections of the CD-ROM. So what did you think about the images on the CD-ROM?

S19: Very good the graphics side of it. IT was actually quite surprising how good they actually were. You can sometimes get these programs and the graphics aren't there at all so yeah it was very impressive.

INTERVIEWER: How did they help in understanding the information?

S19: A lot again because of the colour and the detail that has gone into the graphics has made it a lot easier than just looking at a black and white line drawing. Because it has different colours and because you can see the depth of it and all the rest of it that's what I liked about it.

INTERVIEWER: How do you think the images compared to the images on the videotapes and the course texts?

S19: I still say they were better on the CD-ROM because on the video because you are watching it on the TV you don't sit right next to it you sit further back and it's not as clear as it is on here [the CD-ROM], it's very clear.

INTERVIEWER: The other thing you can see there on the screen is text. You have text round the diagram and the text button. If you could click on that button. What did you think about the text on the CD-ROM?

S19: [PERFORMS ACTION]. It was good because in my experience of reading the book that little bit would be like four or five pages, it's [the text box] more concise, more of a summary which is easier to take in than half a dozen pages of it.

INTERVIEWER: You had in some text boxes, like the one there, some words in blue. What is the significance of those?

S19: They're particular areas that have more text associated with it. Just click on it and it comes up.

INTERVIEWER: What did you think about that facility.

S19: That was alright as well, that was good. I think you can get the same information, I could be wrong, from another screen [TRIES]

INTERVIEWER: What about the fact that you could click on the Text on the diagram as well?

S19: Yeah, again if you click on to it the screen became that particular area more in-depth [referring to layering hotspots].

INTERVIEWER: If you click on the Help button and click on SHOW HOTSPOTS. What has it actually done?

S19: [PERFORMS ACTION] Highlighted the main areas, I think.

INTERVIEWER: What it does is show you the things on the diagram that you can actually click on. How did you actually know what to click on when you were using the CD-ROM?

S19: The arrow changed [the cursor].

INTERVIEWER: So did you go around the screen with the mouse looking for things to click on?

S19: Yes.

INTERVIEWER: Did you click on everything that you could?

S19: Yes, anything that changed. Curiosity.

INTERVIEWER: The other thing as well, is that you have to bring the text up yourself. So what did you do, look at the diagram first and then click on that text button or...?

S19: Click on all the pieces and look at the diagram and then look go to the text.

INTERVIEWER: Narration. Did you listen to the narration at all?

S19: Yes.

INTERVIEWER: What did you think about the narration?

S19: It was alright. It was quite clear as well and again it's hearing the information rather than just looking at it so it was an added benefit of learning it.

INTERVIEWER: We've talked about the diagrams and the text helped you to understand the information on the CD-ROM. Did the narration help as well?

S19: Yeah, just looking at it and clicking on the text you sort of got where the bits were and what they done but actually listening to someone tell you what it done as well just made it a bit more easier to understand because you can read stuff and you can sometime get lost and a bit confused, whereas if you got someone to tell you what you have just read you understand it a lot easier. So having it actually spoken to you as well made it a lot easier to understand.

INTERVIEWER: Did you listen to the narration all the way through?

S19: No only bits of it. In hindsight I should have probably of listened to it more.

INTERVIEWER: So what did you do, turn the sound the down?

S19: Yes, most of the time the sound is turned down on this anyway [the computer]. It's probably the first time I used it [the CD-ROM] and a few times after that I turned the sound up and used the narration. Then after that, because you are just going through the screens and learning it, it's forgetting to turn it up and then just not use it. When I first jumped on it I had a go at everything but then when I actually started using it for a purpose...if I didn't understand then I'd try and listen to the thing to see if it made a better understanding of it.

INTERVIEWER: Did the narration help with the pronunciation at all?

S19: Yeah, definitely because again in this course and the previous courses because you are doing it on your own you are reading words and you're saying them how you think they should be said and then when you go in and somebody says something you're thinking 'what the hell are they're talking about' then you suddenly realise that it's what you done that you've been saying it a completely different way. So that made it a lot easier, you felt more comfortable with the words then.

INTERVIEWER: One of the things about the information on the CD-ROM was that it was organised into layers of increasing complexity. What did you think about that organisation?

S19: That was good because it started form the basic level and then went into it. Also because it's all on the same screen it's not having to...at the beginning you had the Overview, the Hands on the brain [referring to contents screen]...you didn't have the Overview and then all the bits associated with it. You just went to that screen and then went through, went deeper into it that was better.

INTERVIEWER: You talked about the QuickTest earlier. What did you think about the QuickTest?

S19: Good, makes sure you understood it.

INTERVIEWER: When would you use it: would you go through the whole of section and then do the questions?

S19: Yeah use it at the end to make sure I had hopefully understood most of it.

INTERVIEWER: How did that work with the Cerebral Cortex because you did that over a series of sessions so did you leave the questions right until the end?

S19: Right until the end.

INTERVIEWER: What do you think they were testing. What you picked up from the CD-ROM or what you picked up from the books or a combination of both?

S19: If I can remember rightly, you needed both. A fair bit of it was for the CD but some of it [needed the book]

INTERVIEWER: Did you answer all the questions?

S19: Yes.

INTERVIEWER: Did you get any wrong?

S19: Some of them I did.

INTERVIEWER: What happened with those questions you got wrong?

S19: Went back to find out what the answer was and then more or less came up with what it was and then just went back to the screen and read it again

INTERVIEWER: The objectives did you use those?

S19: I clicked on them and looked at them and it was handy...I used them at the beginning so I knew what I was aiming for at the end and what were the more important bits to pick up on.

INTERVIEWER: It sounds like you have two sorts of checklists going: one at beginning which is the objectives and one at the end which is the QuickTest. Do you think that would be a fair assessment?

S19: Yeah, because as I say I like fiddling with the computers at least having the objectives I was going in a direction rather than just clicking all over the place and *having a jolly good time.*

INTERVIEWER: I'd like to look at the Tool button with you now. Could you click on the TOOL button for me. Can you recall what tools you did use?

S19: [PERFORMS ACTION]. I did use some of these. I can't remember what I used but I can remember having a go at these.

INTERVIEWER: Well let's take a look at some of these. If we start with the Glossary. Can you open the Glossary for me.

S19: [PERFORMS ACTION].

INTERVIEWER: Did you use this tool?

S19: SHAKES HEAD, by the look of it you put in the name you are looking for and then it will look for it and bring it up on the screen as a summary.

INTERVIEWER: What are the letters for at the top of that window?

S19: Ah if you click on A, B, C, or whatever does it bring up terms starting with that letter?

INTERVIEWER: Try it, see what happens

S19: [PERFORMS ACTION].

INTERVIEWER: You were right on both counts. Do you remember using this now?

S19: No

INTERVIEWER: Did you use the text based glossary at all?

S19: Yeah I did.

INTERVIEWER: If you came across a term on the CD-ROM you didn't understand or you wanted to look up...

S19: I looked it up in the book.

INTERVIEWER: Did that ever actually happen whilst using the CD-ROM?

S19: Yeah and I looked it up on the book.

INTERVIEWER: So now you have seen this..

S19: I'm gutted because I saw it and I saw the glossary and I thought that's going to be to do with just the brain but now that I have just seen it, it's to do with everything.

INTERVIEWER: Can you click on the Camera for me?

S19: [PERFORMS ACTION AND CLICK HEARD]

INTERVIEWER: Did you hear that?

S19: I heard a click.

INTERVIEWER: What do you think has happened?

S19: It's taken a picture of this or something [referring to the screen behind].

INTERVIEWER: If it has done where is the picture?

S19: I don't know.

INTERVIEWER: Okay, if you click on the Photo Album for me?

S19: [PERFORMS ACTION, EXAMINES CONTENT SHOWING PICTURE]. Aha...

INTERVIEWER: So you were right, it has taken a picture. If you double click on that picture what do you think you can do now?

S19: Move it around I think. I don't know.

INTERVIEWER: What you can do you can type your own notes.

S19: Ahh...

INTERVIEWER: So you can annotate the picture now. Did you use the Camera and the Album?

S19: I clicked on the Camera but didn't actually work out what happened until you just showed me.

INTERVIEWER: What do you think it would be useful for or what would use that for?

S19: I thought it would be when I clicked on it, it would be more pictures rather than taking a picture but seeing how it works now you could use it and notes you take from the text you could put on the album and use as it as additional information.

INTERVIEWER: Did you ever want to put any of the images into TMAs?

S19: That would have been handy, yeah.

INTERVIEWER: You can do that with that as well.

S19: Then you could print it off...ah.

INTERVIEWER: Did you print off anything?

S19: I didn't actually.

INTERVIEWER: Would you have liked to?

S19: Yeah this goes back to reading the instructions.

INTERVIEWER: The last thing you can click for me – Notepad.

S19: [PERFORMS ACTION].

INTERVIEWER: What's this do?

S19: That's the same on all computers you have Wordpad.

INTERVIEWER: Did you use this at all?

S19: No.

INTERVIEWER: Did you make any notes from the CD-ROM?

S19: A few but those were hand written and put in a folder, just from the text boxes.

INTERVIEWER: Did you try and copy down any of the diagrams into your notes?

S19: No, I didn't.

INTERVIEWER: Did you use the notes you took to revise?

S19: Yes, I did. The reason, going back to did I take any notes, it's hand-written because I have in the past tried using a computer to write my notes but because I am one fingered job it takes a lot longer to actually type it than write it so I always wrote the notes out.

INTERVIEWER: Did you make notes from the other course material, the texts, the videos...?

S19: Oh yeah I used notes for anything.

INTERVIEWER: That's essentially it. I suppose the last question I have but you have used it for quite an extended period of time was there anything you thought that this really could have done with?

S19: I think with the course, it took ages for me to understand in Form and Function, with like the Nervous System, I know a lot of it is to do with the psychology, but the Nervous System side of it would be good to see things moving. It is very difficult when you looking at pictures and reading text especially about how nerve impulses travel and what actually happens in the nerve cell, but you would probably need a computer with good graphics and animations.

INTERVIEWER: Did you experience any problems using it?

S19: No it worked find.

INTERVIEWER: Well that's it if there is anything you would like to add?

S19: Very add is all I can say about it, this is the first course I have done which has a CD-ROM and I think it would be helpful to have a CD-ROM on other courses as well.

INTERVIEWER: OK thank you very much indeed.